US006460705B1

(12) **United States Patent**
Hallowell

(10) **Patent No.: US 6,460,705 B1**
(45) **Date of Patent: Oct. 8, 2002**

(54) **METHOD OF CREATING IDENTIFIABLE SMALLER STACKS OF CURRENCY BILLS WITHIN A LARGER STACK OF CURRENCY BILLS**

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(73) Assignee: **Cummins-Allison Corp.**, Mt. Prospect, IL (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/635,181**

(22) Filed: **Aug. 9, 2000**

(51) **Int. Cl.**[7] **B07C 5/00**; B07C 5/34

(52) **U.S. Cl.** **209/534**; 209/540; 209/542; 209/545; 271/65; 271/185; 271/186

(58) **Field of Search** 209/534, 540, 209/542, 545; 271/65, 185, 186; 270/52.02, 58.04, 52.01, 58.01

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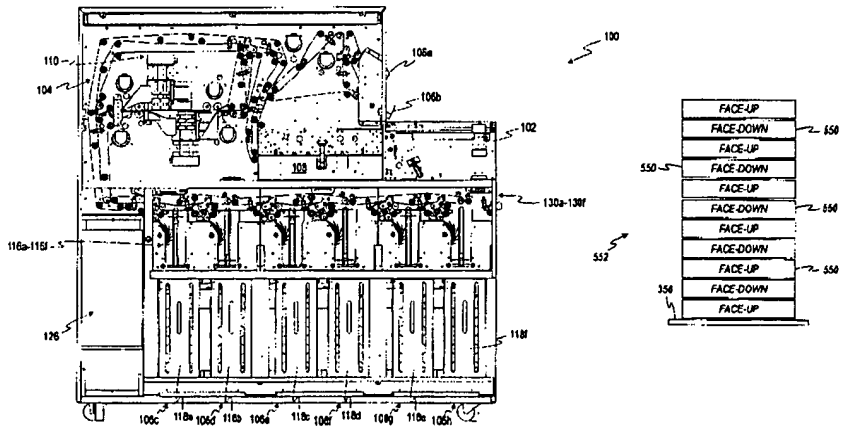
Primary Examiner—Donald P. Walsh
Assistant Examiner—Jonathan R Miller
(74) *Attorney, Agent, or Firm*—Jenkens & Gilchrist

(57) **ABSTRACT**

A method and device for identifying small stacks of currency bills within a large stack of currency bills using a currency evaluation device. A stack of currency bills to be processed is received in an input receptacle and the bills are transported from the input receptacle, one at a time, past an evaluating unit to at least one output receptacle. The evaluating unit determines the face orientation of each of the bills. Next it is determined whether the face orientation of each of the bills matches a target orientation. If the face orientation of a bill matches the target orientation, the face orientation of that bill is maintained. If the face orientation of a bill fails to match the target orientation, the face orientation of that bills is reversed with a bill facing mechanism. Each of the bills are then stacked in the output receptacle. After a predetermined number of bills having a common face orientation are stacked in the output receptacle, the target face orientation is redefined. The bills continue to be processed in this manner until each of the bills are transported from the input receptacle.

66 Claims, 30 Drawing Sheets



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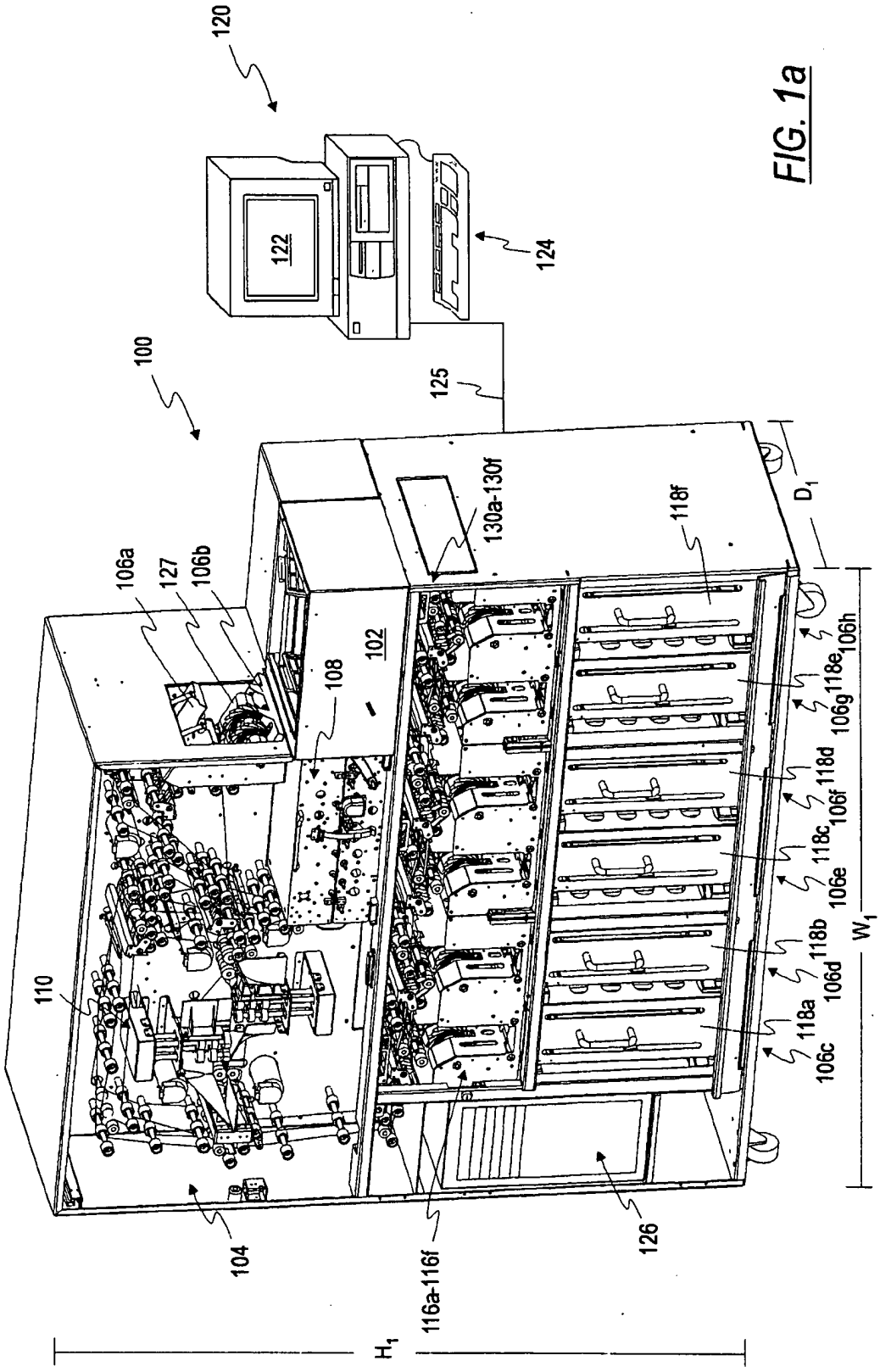
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130a-130f
118f
D_1
106a
127
106b
102
108
106h
118e
106g
118d
106f
118c
106e
118b
106d
118a
106c
W_1
110
104
116a-116f
126
H_1

FIG. 1a

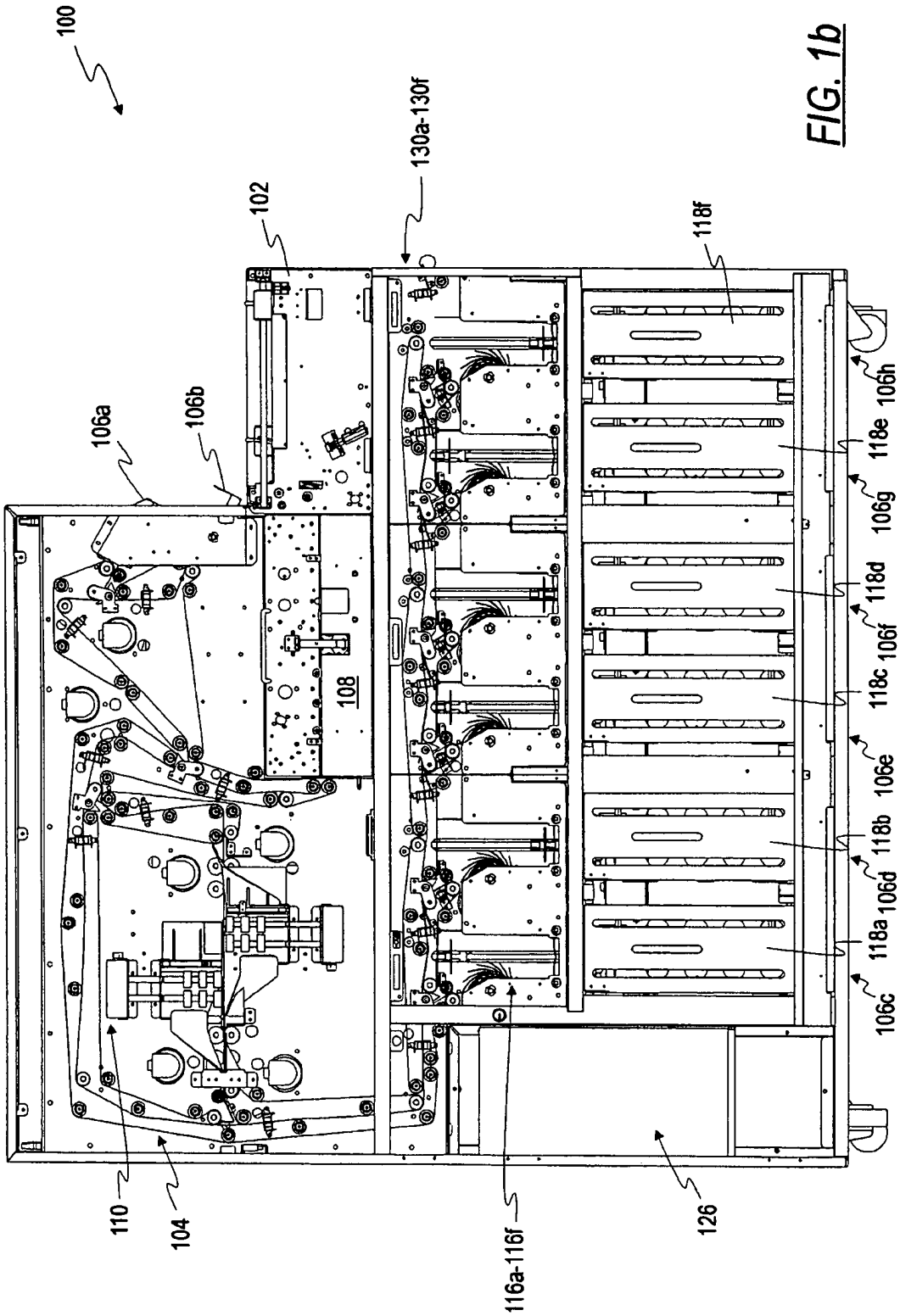

100
102
130a-130f
118f
106a
106b
106h
118e
106g
118d
106f
118c
106e
118b
106d
118a
106c
108
110
104
116a-116f
126

FIG. 1b

FIG. 2a

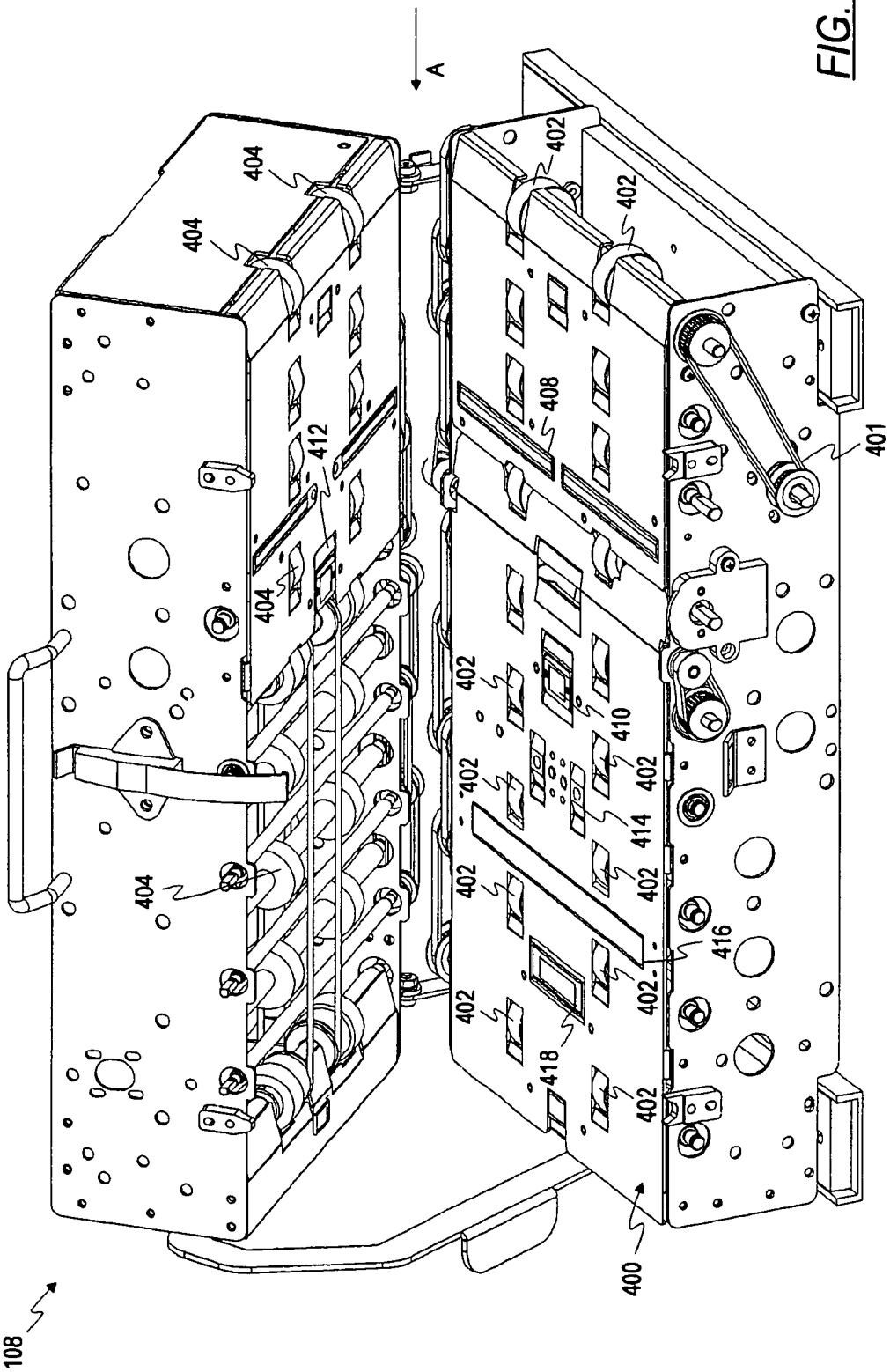
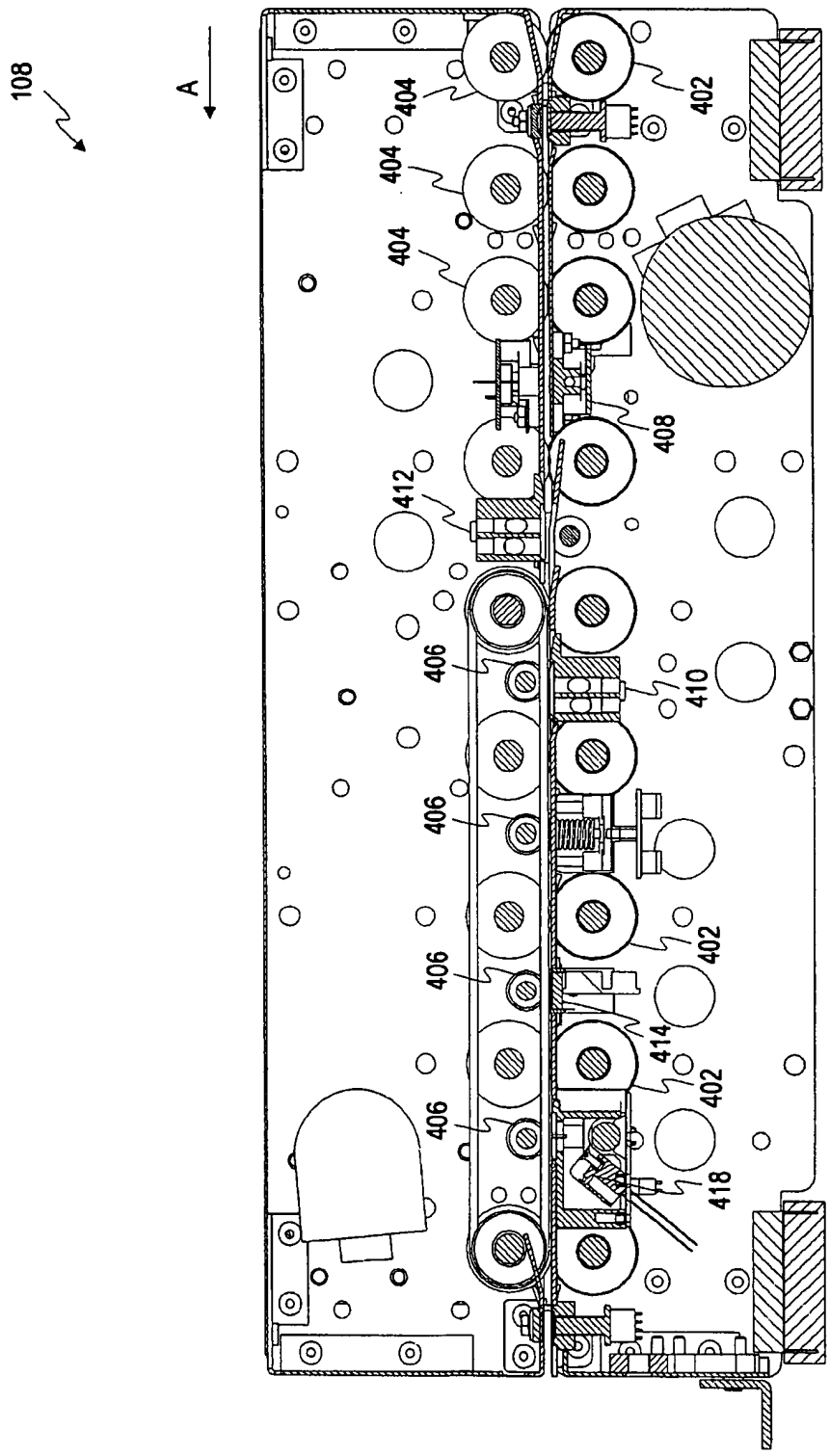


FIG. 2b


108
A
404
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406
418

FIG. 3a

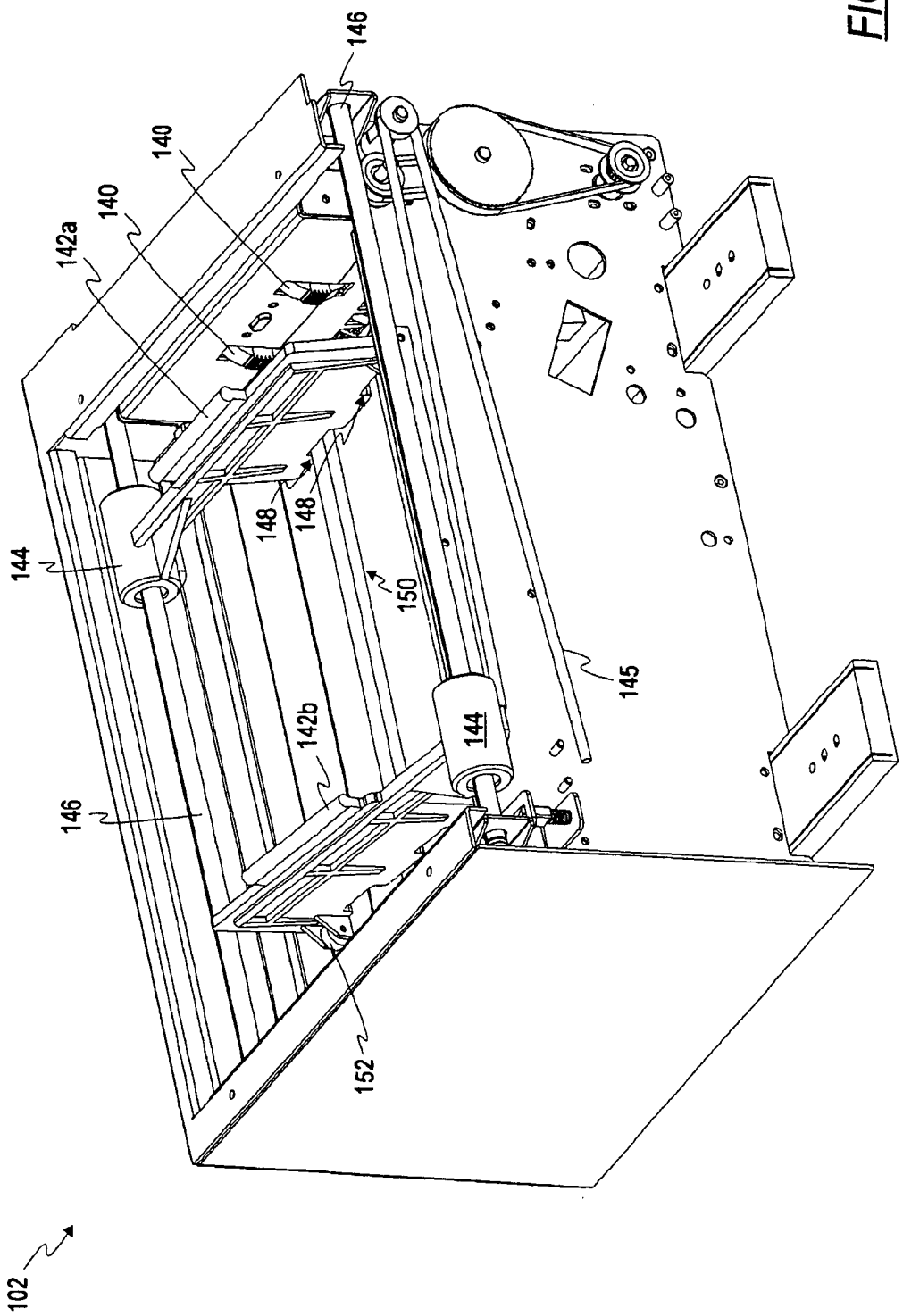


FIG. 3b

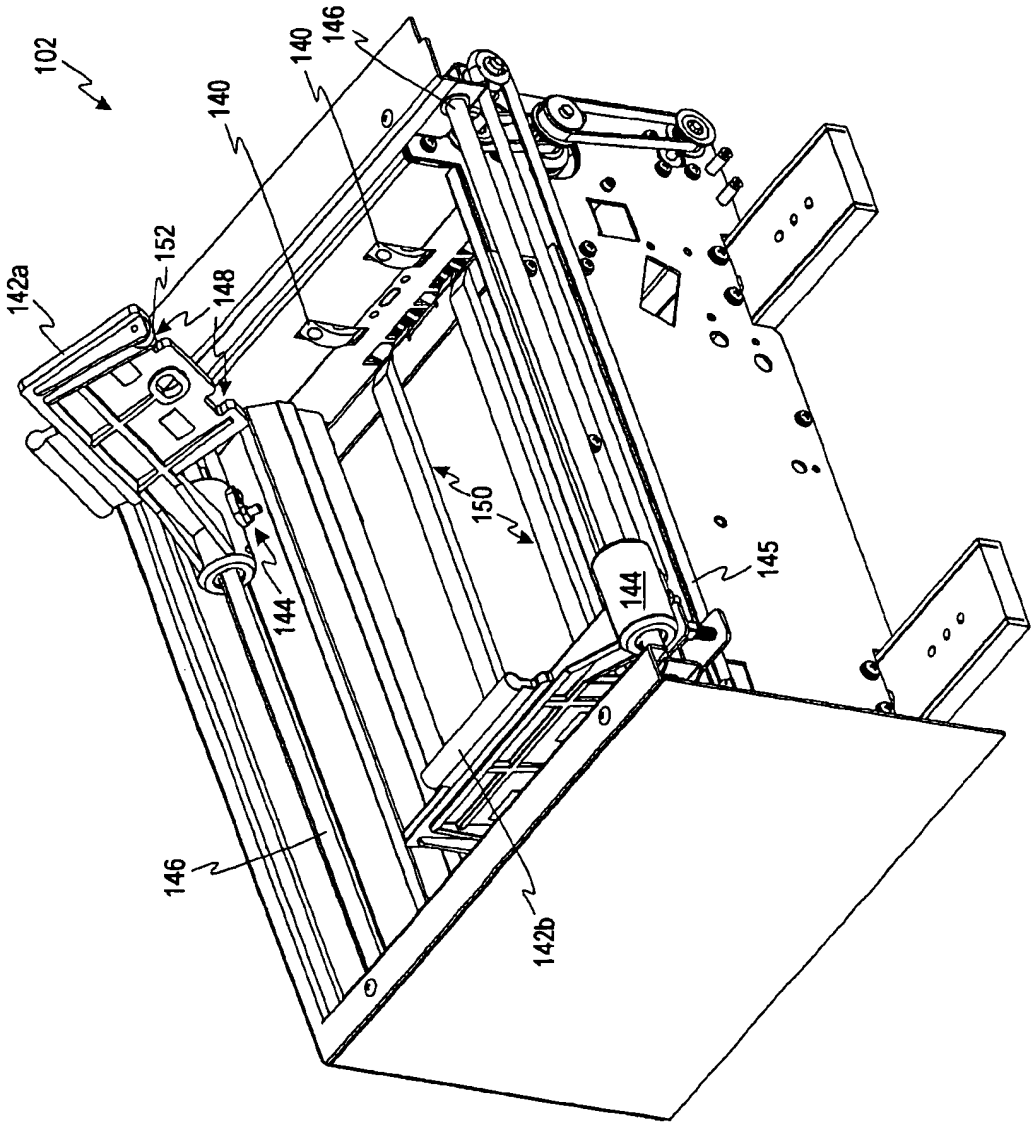


FIG. 3c

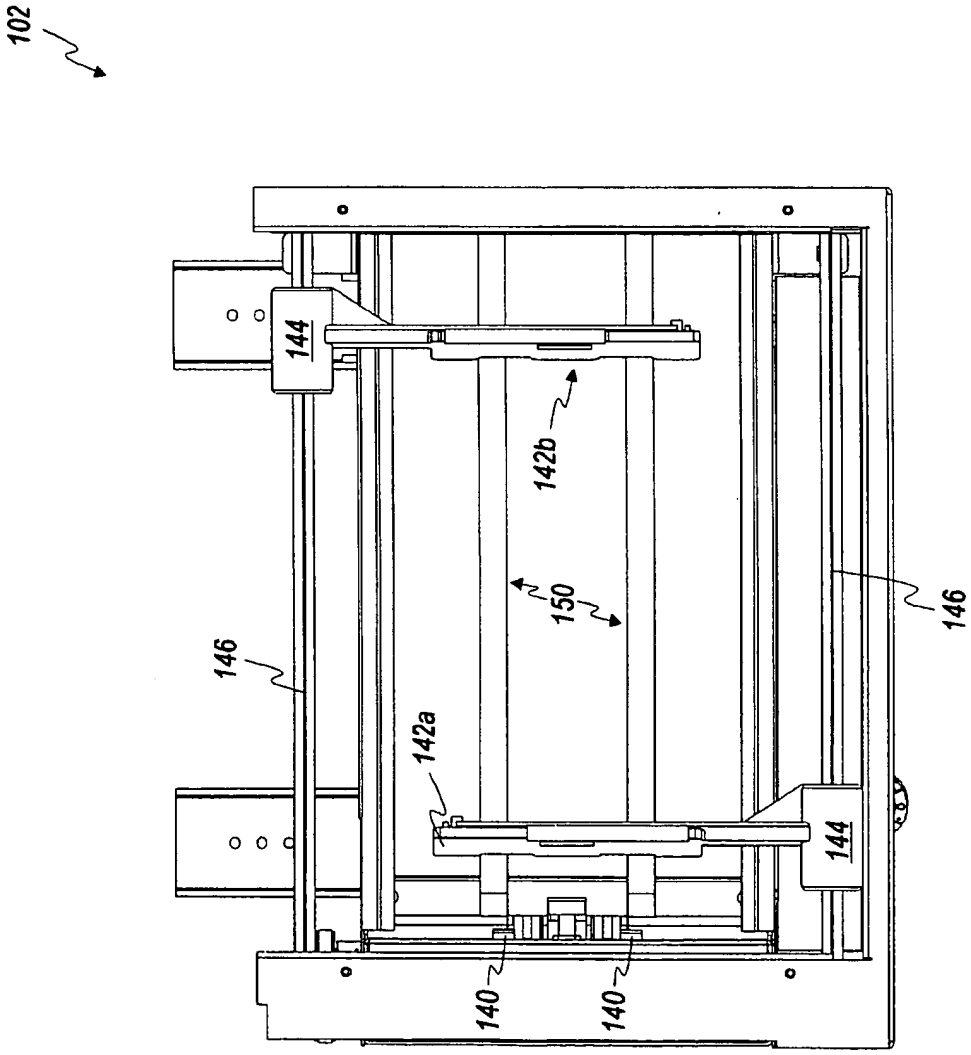
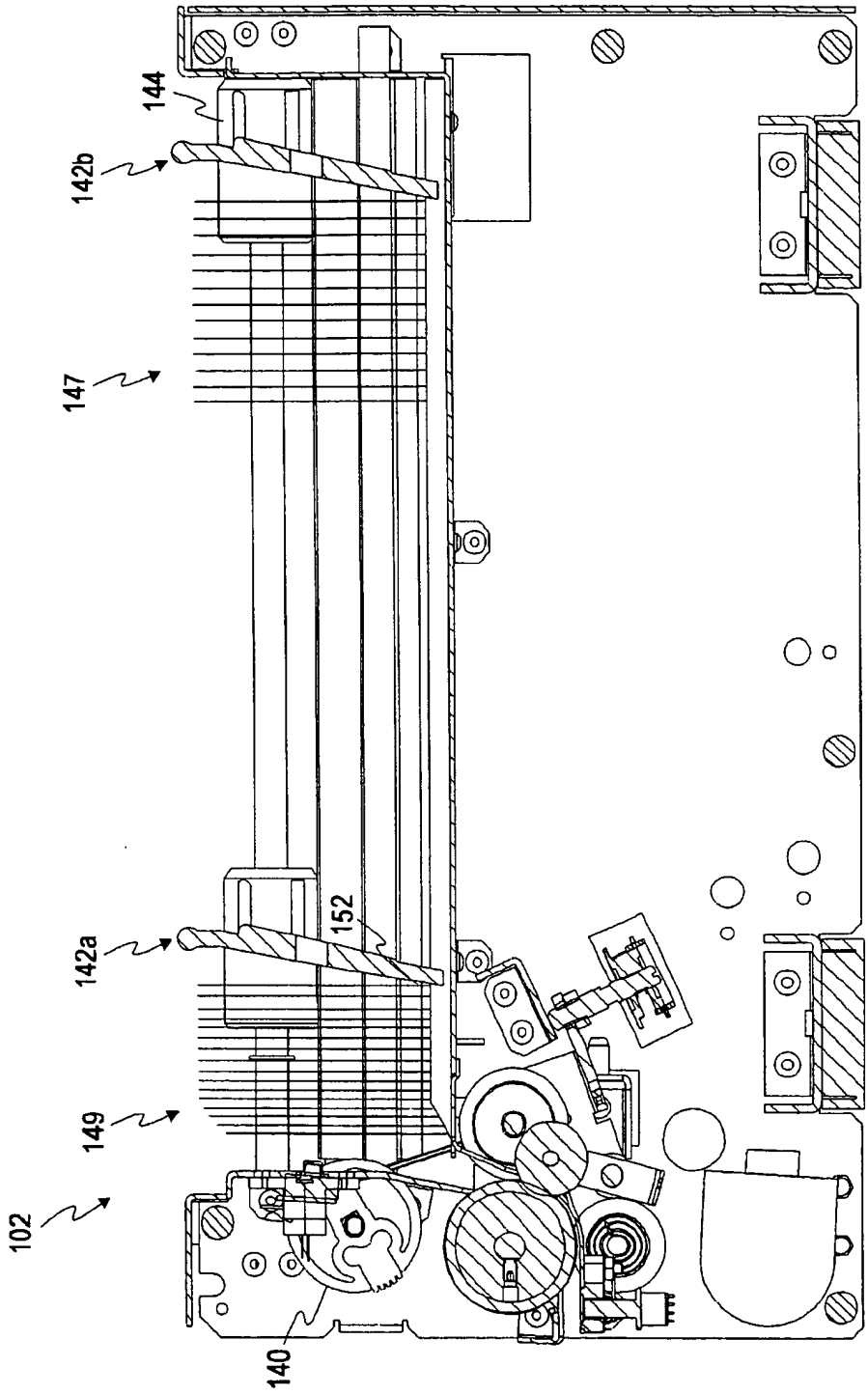


FIG. 3d



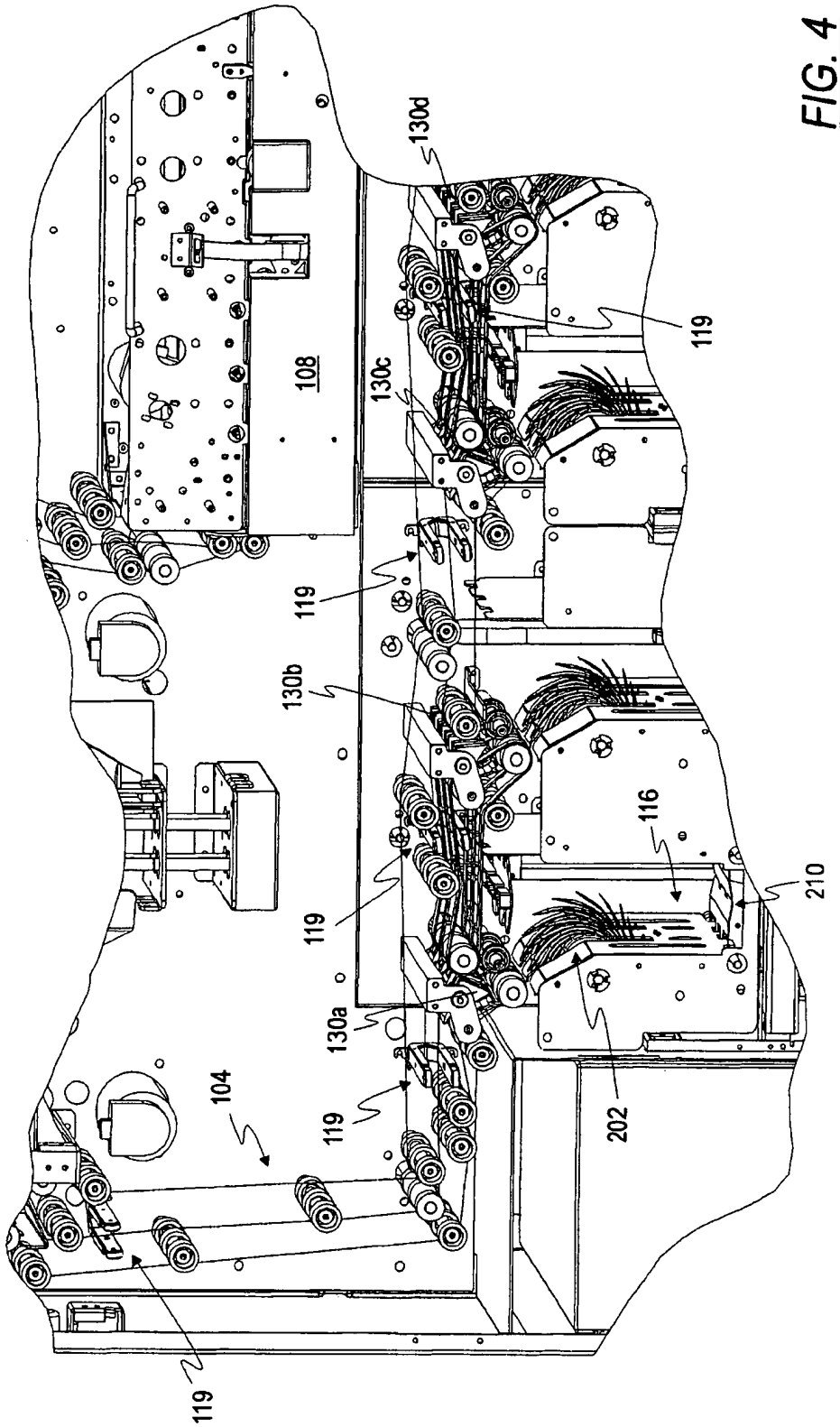


FIG. 4

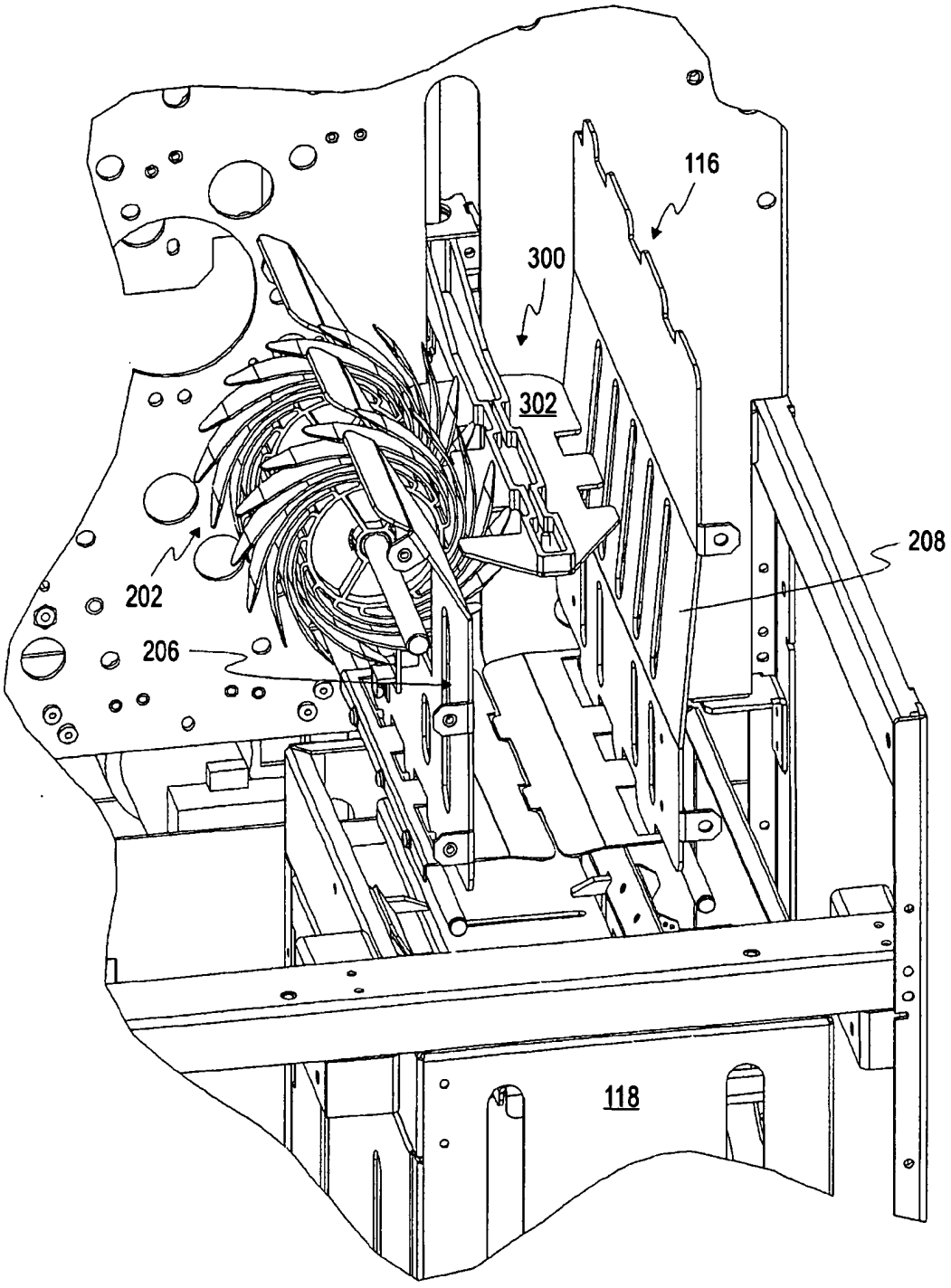


FIG. 5

FIG. 6

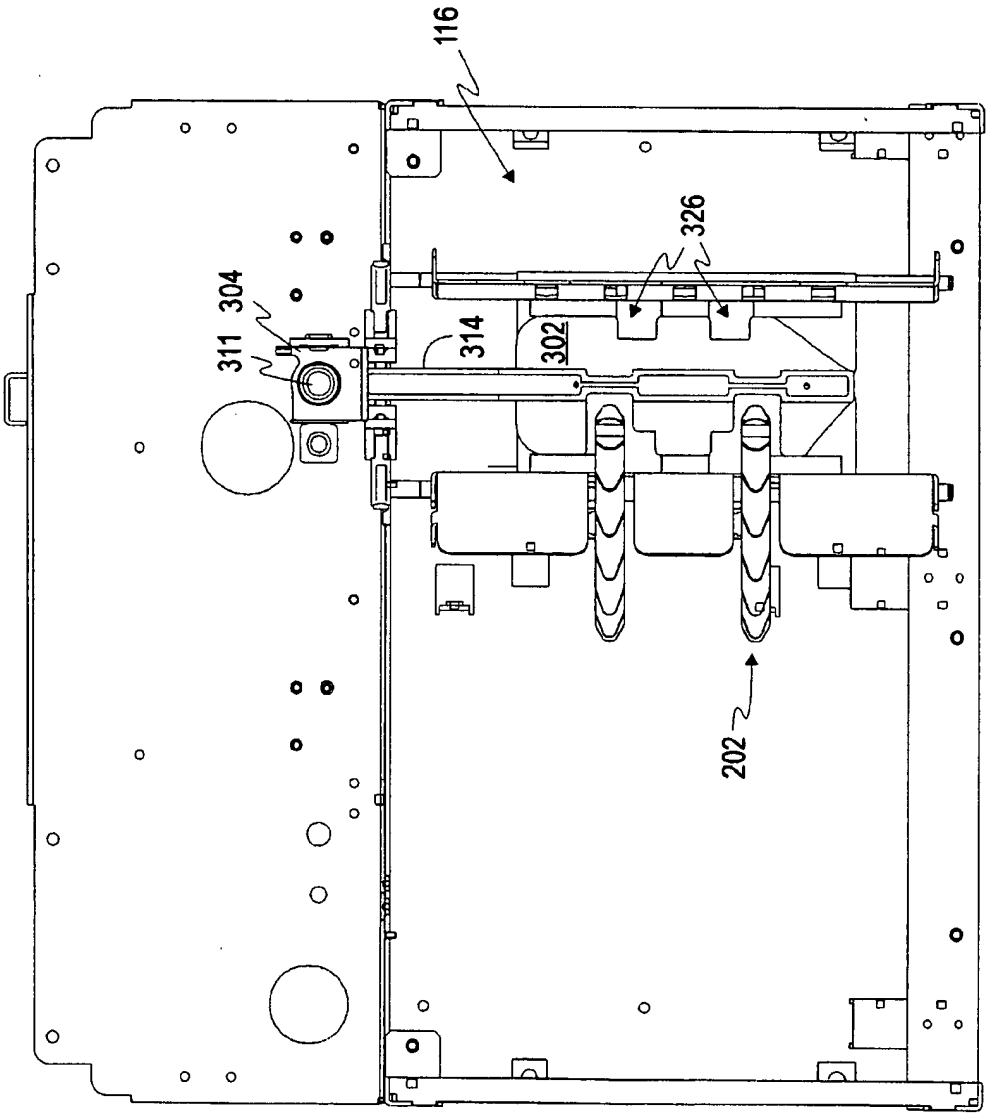


FIG. 7

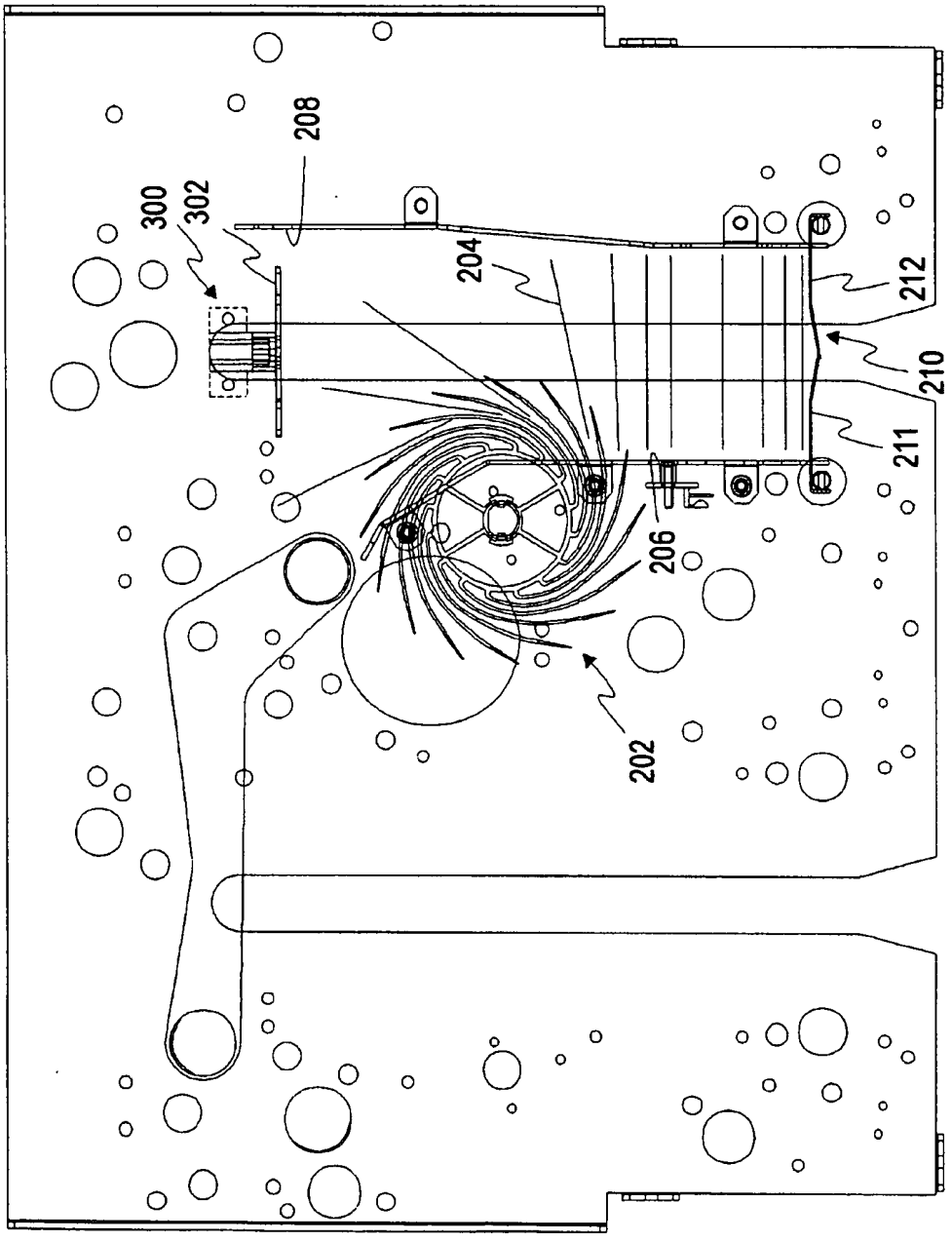
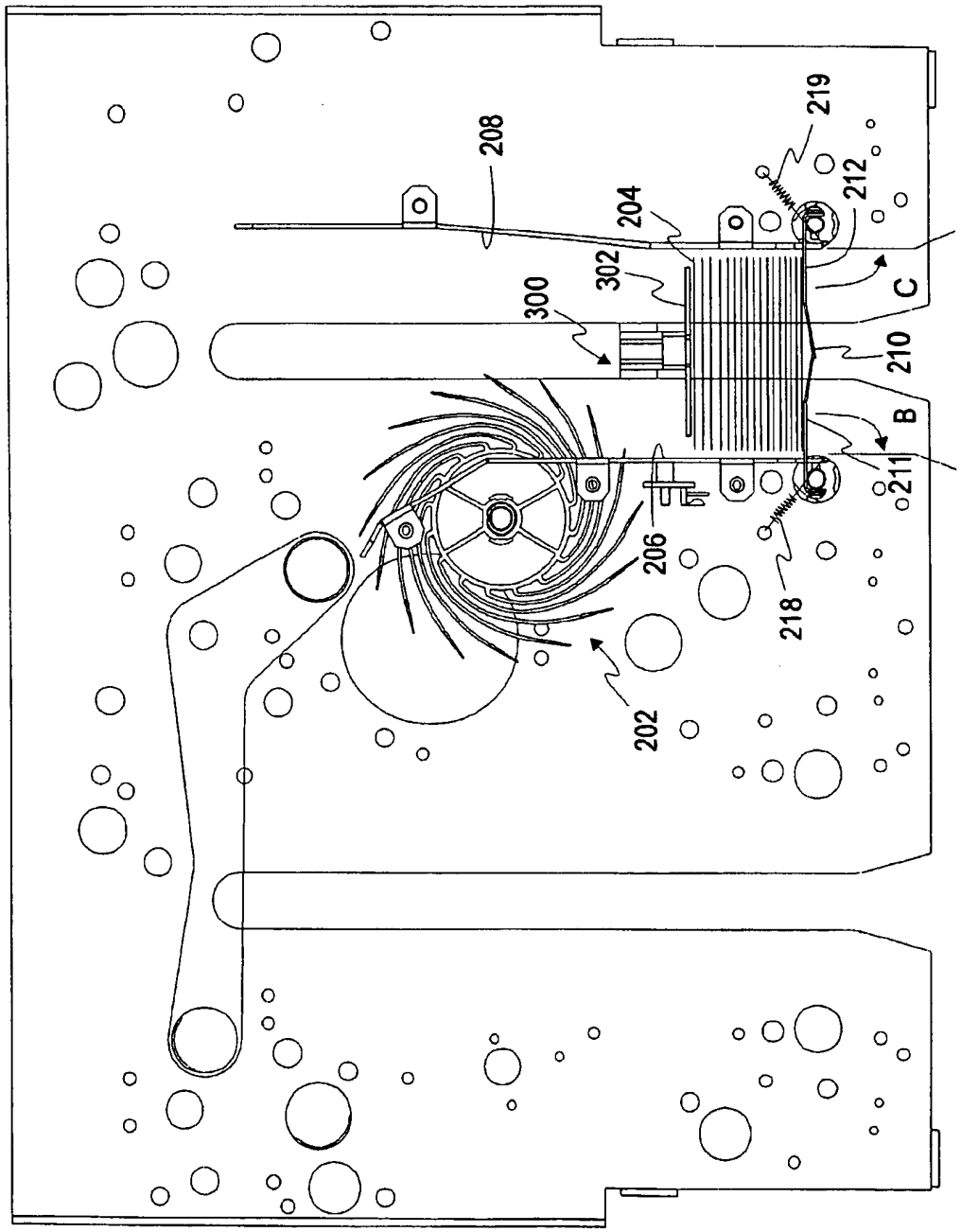
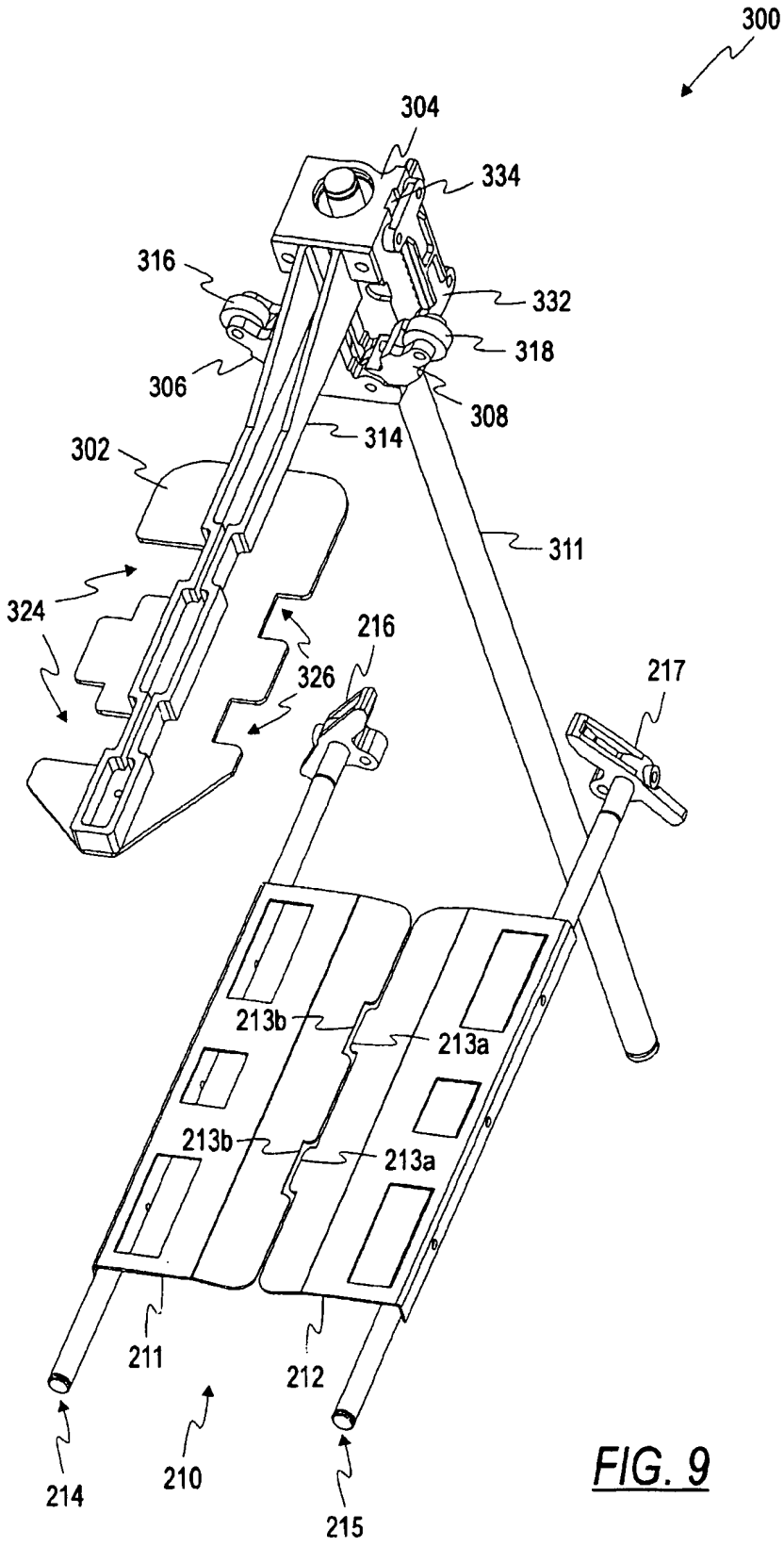


FIG. 8

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306
308
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326
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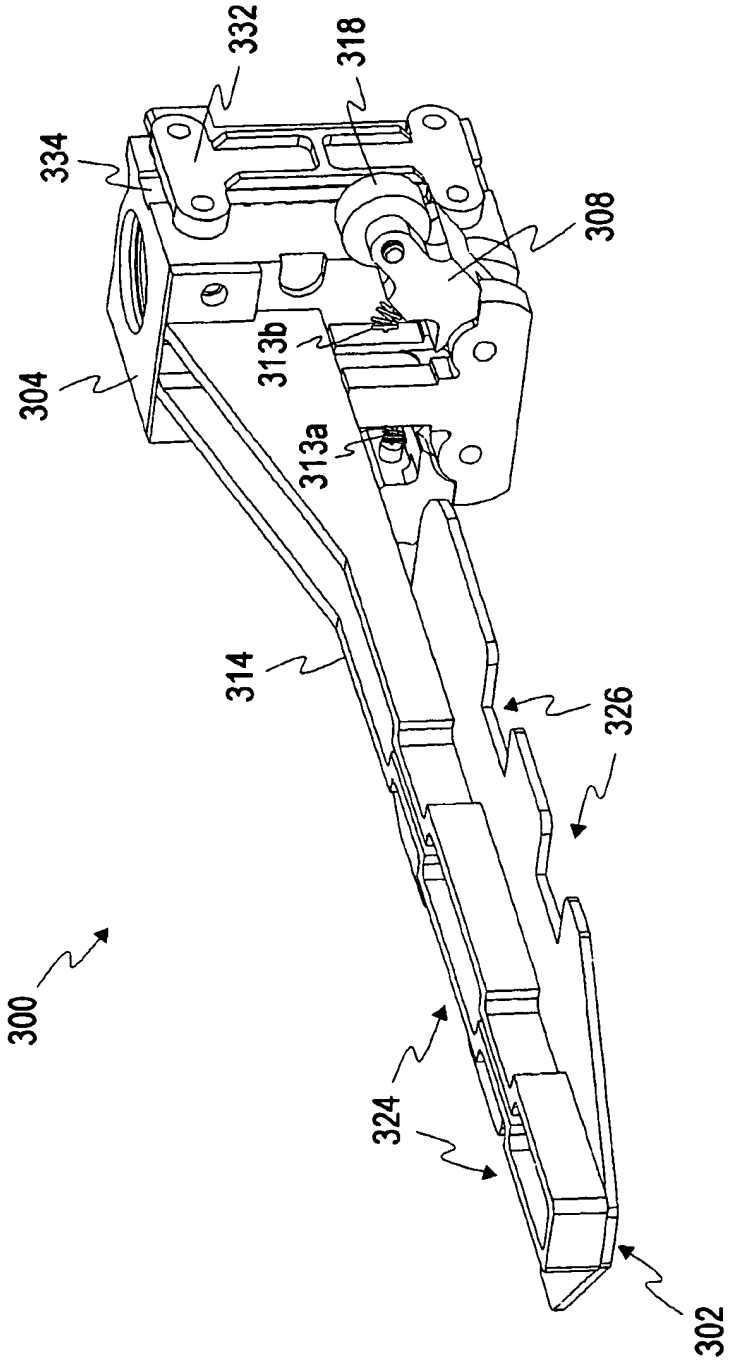
213b
213a
213b
213a
211
212
214
210
215

FIG. 9

FIG. 10



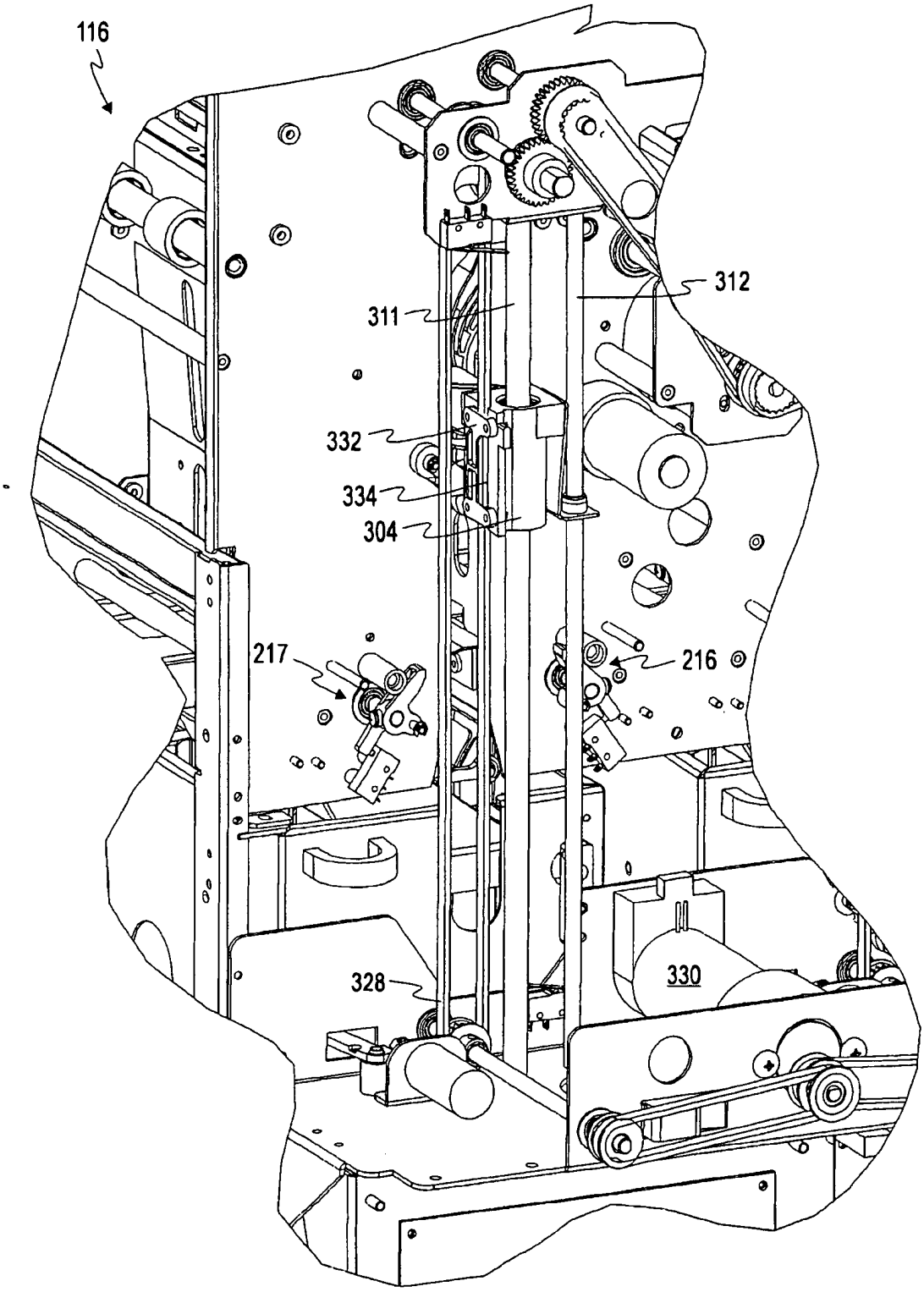


FIG. 11

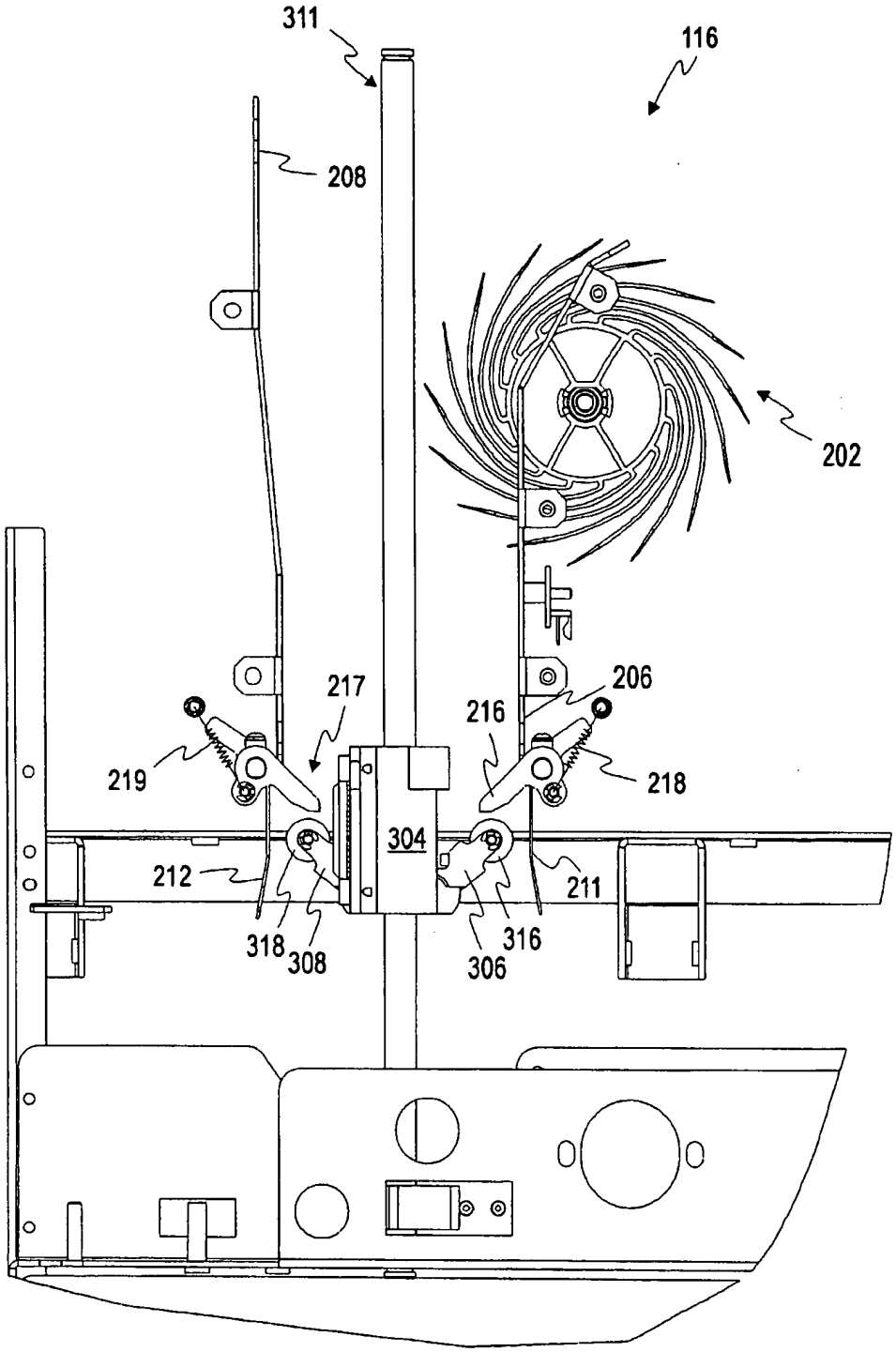


FIG. 12

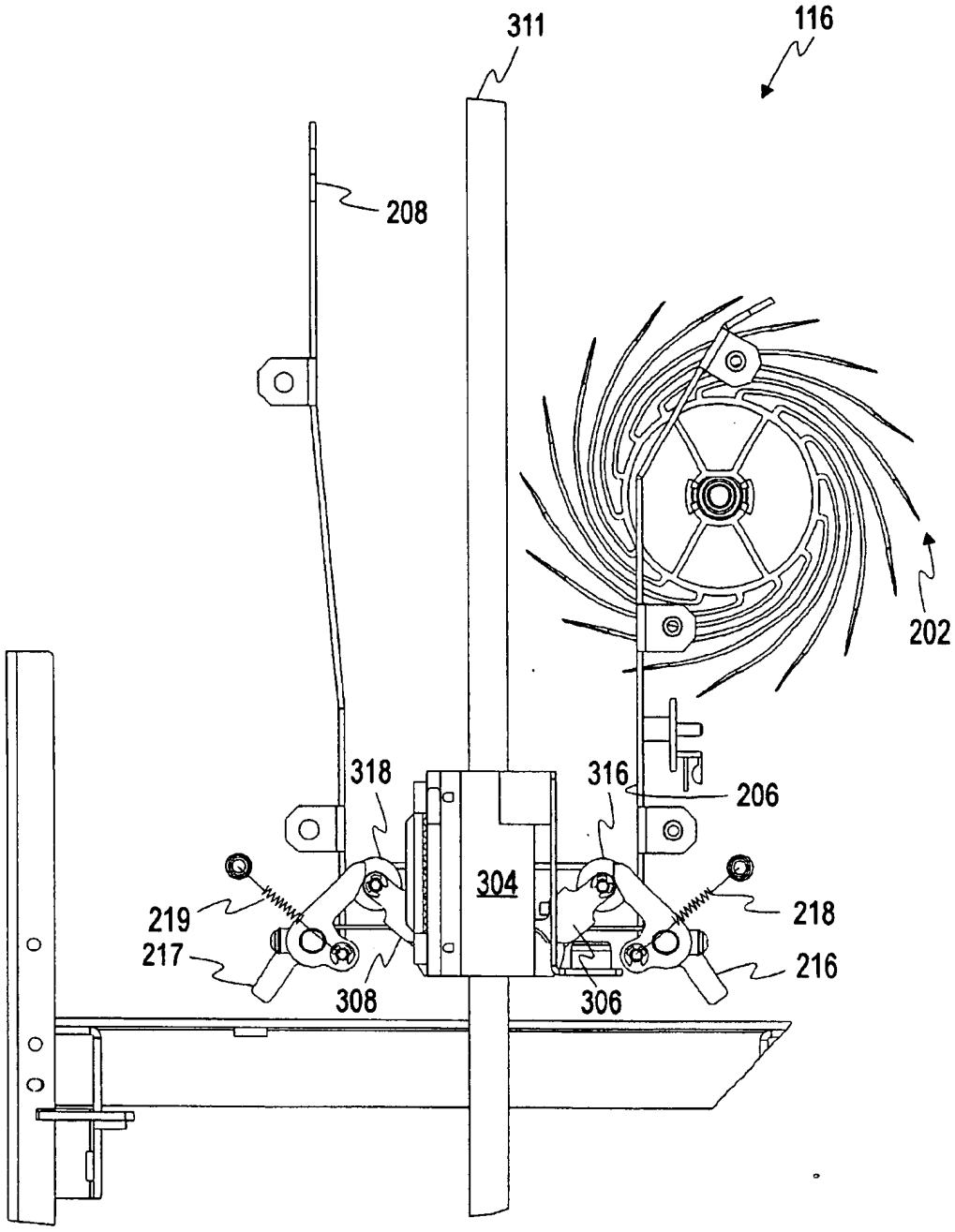


FIG. 13

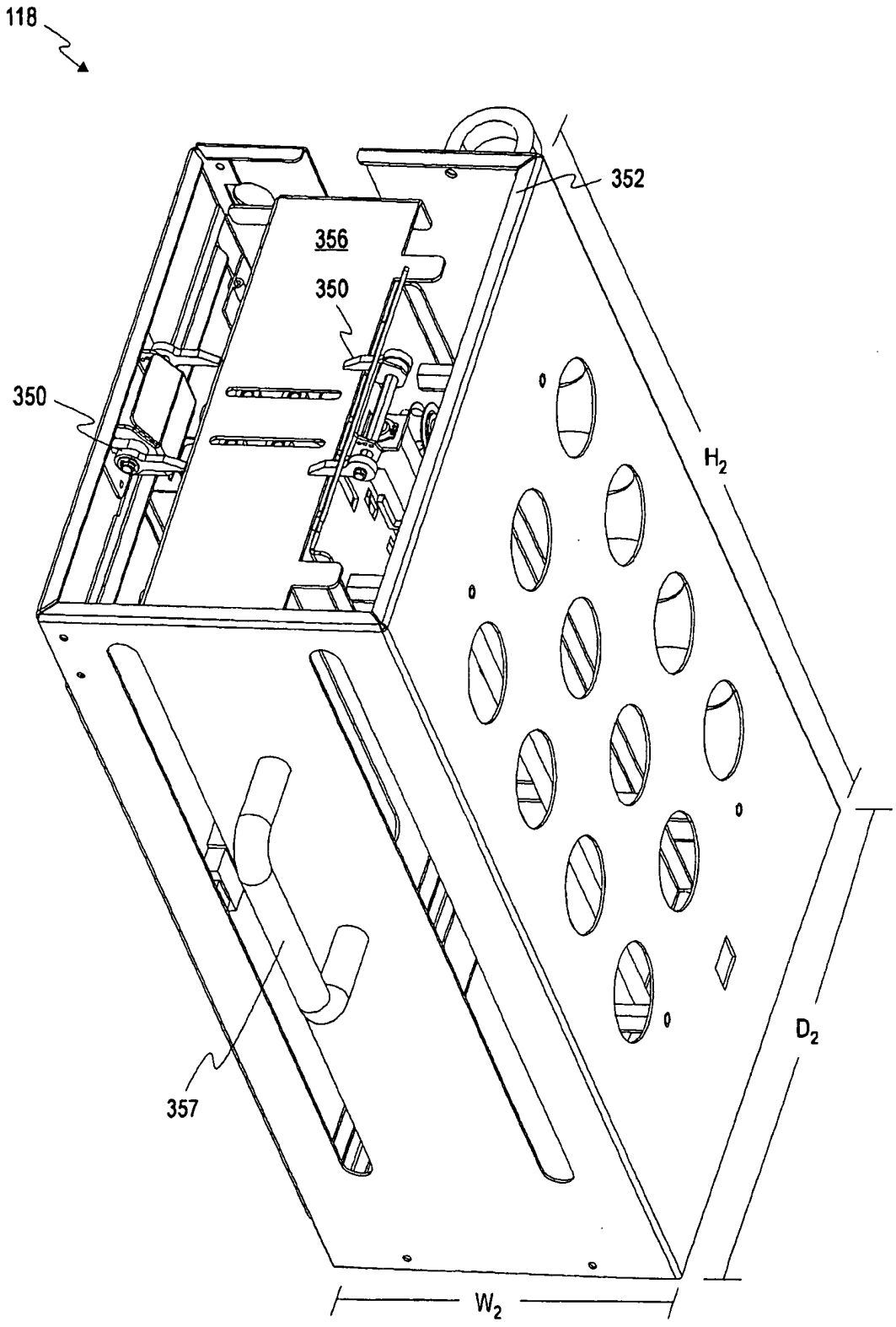
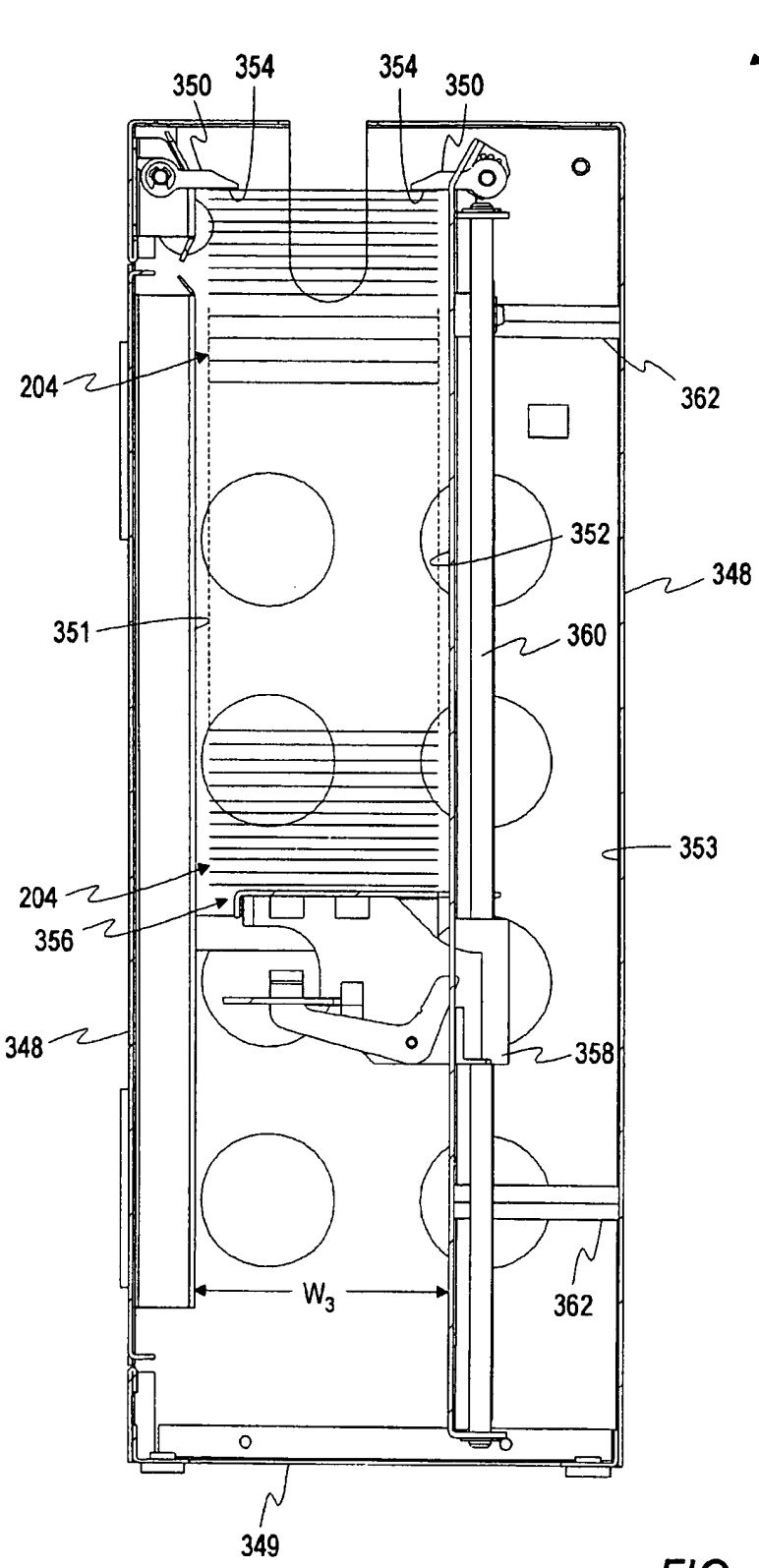


FIG. 14


118
350
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362
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204
356
348
358
W_3
362
349

FIG. 15

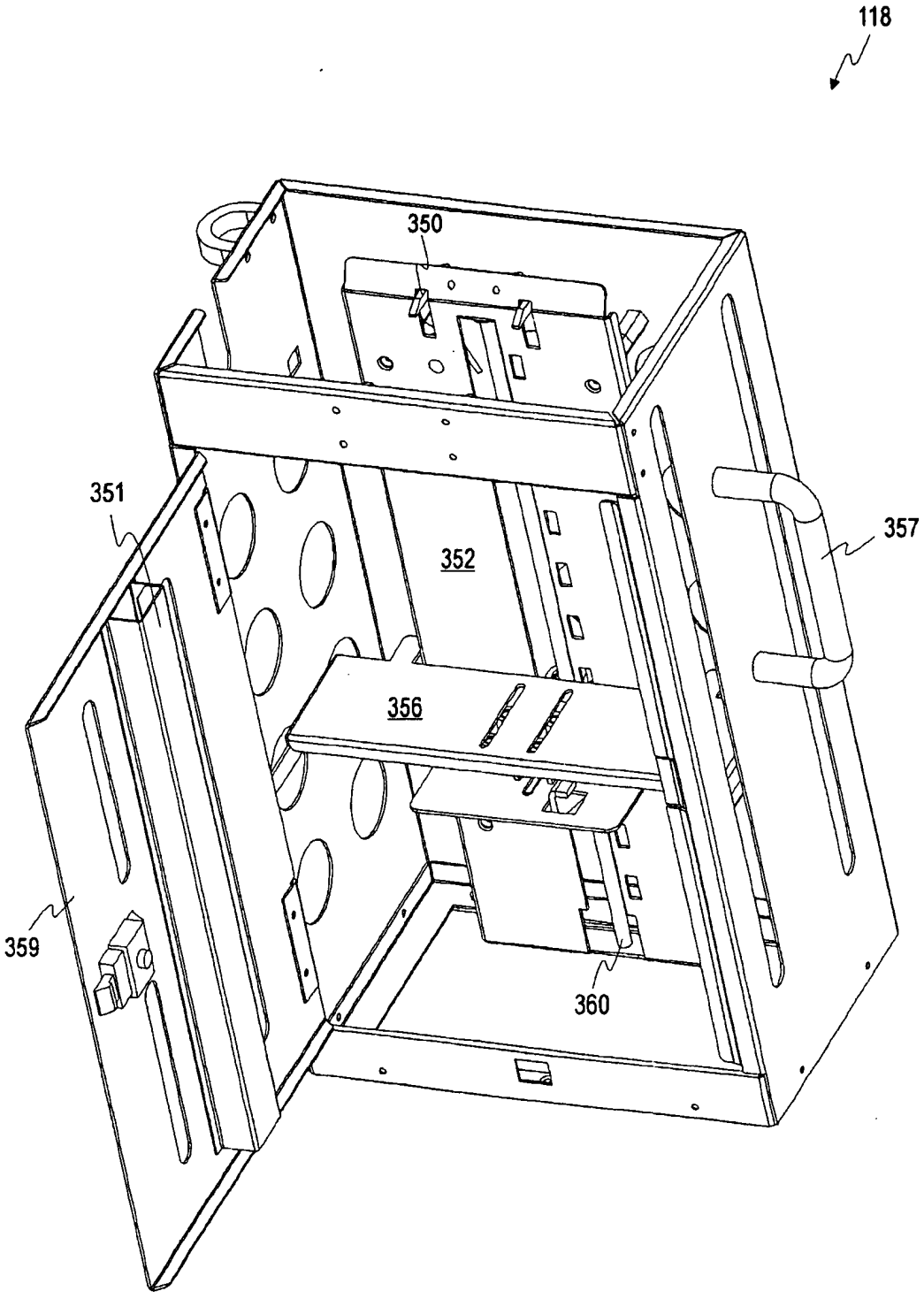


FIG. 16

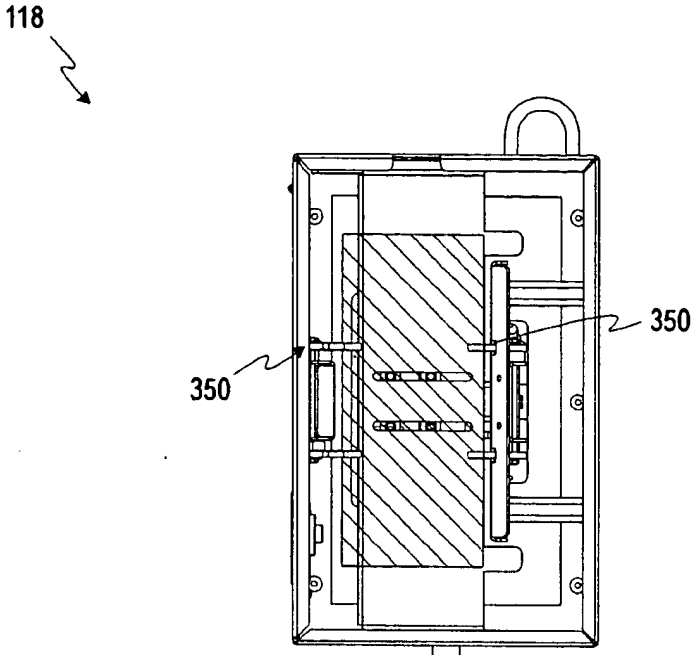


FIG. 17a

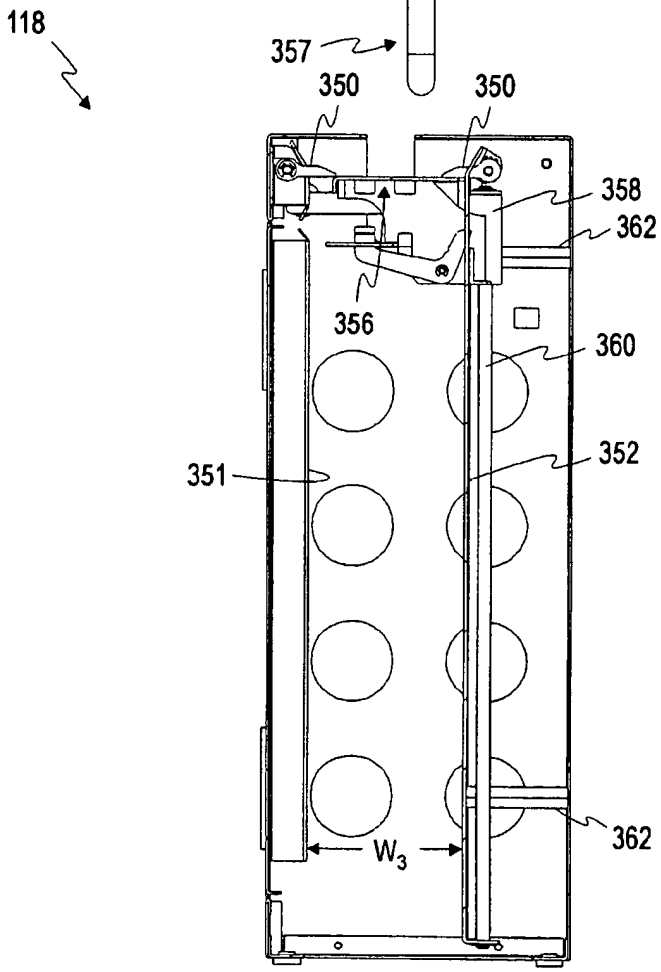


FIG. 17b

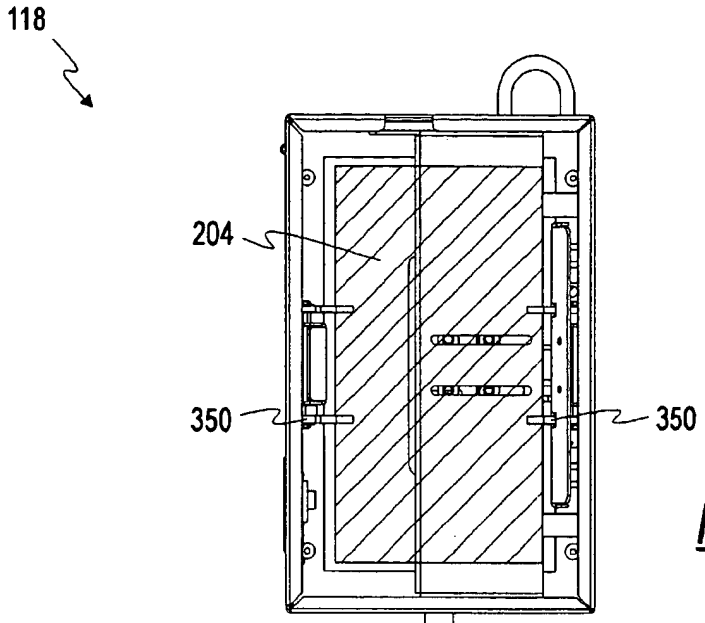


FIG. 18a

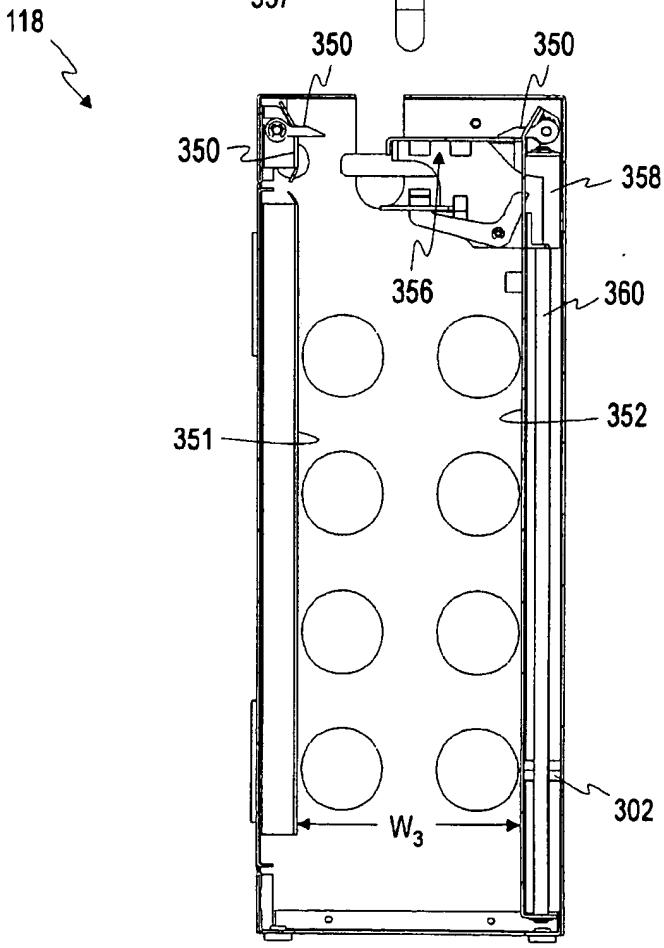
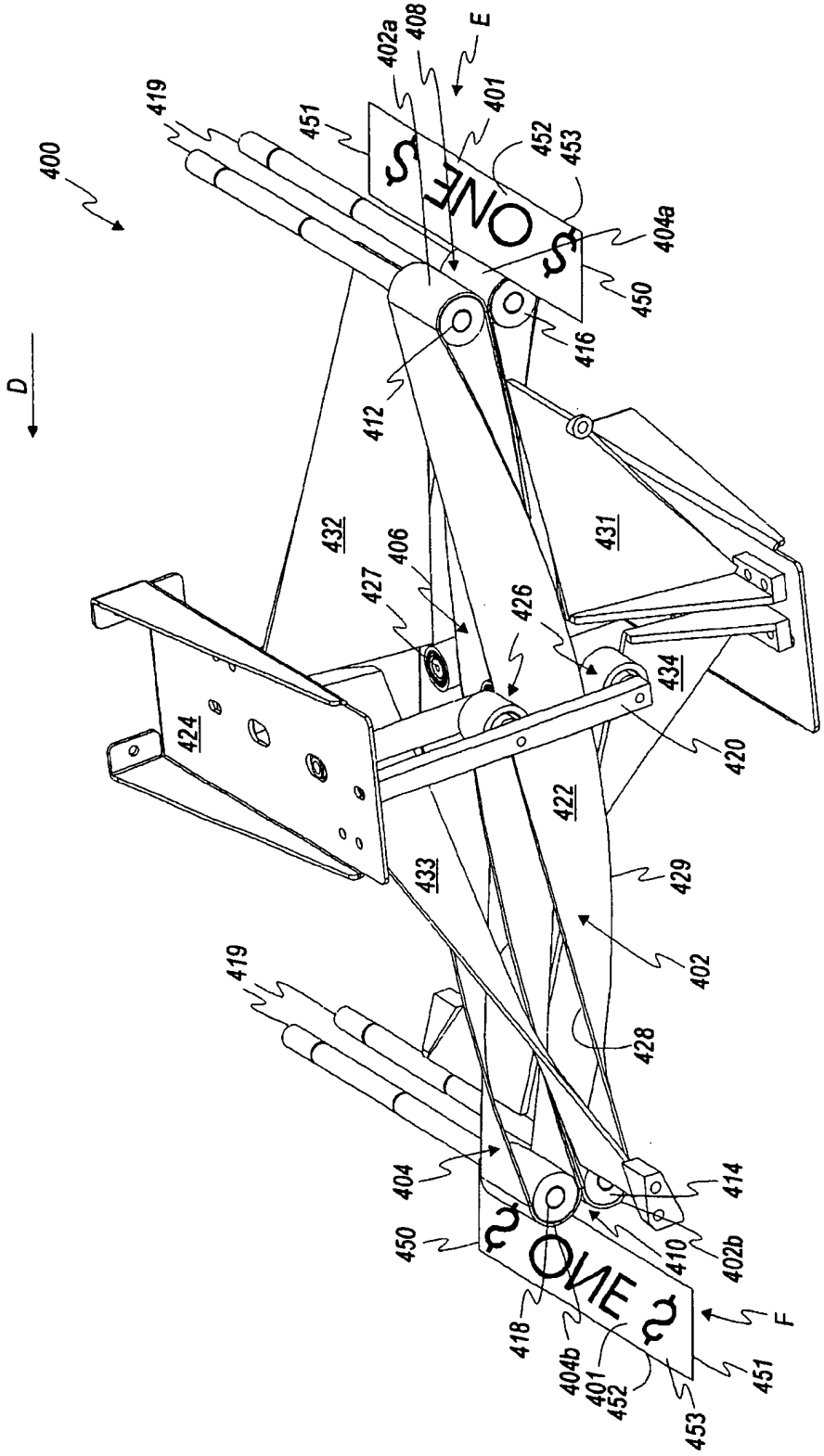


FIG. 18b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404a
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ONE
TWO
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406
427
426
434
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402b
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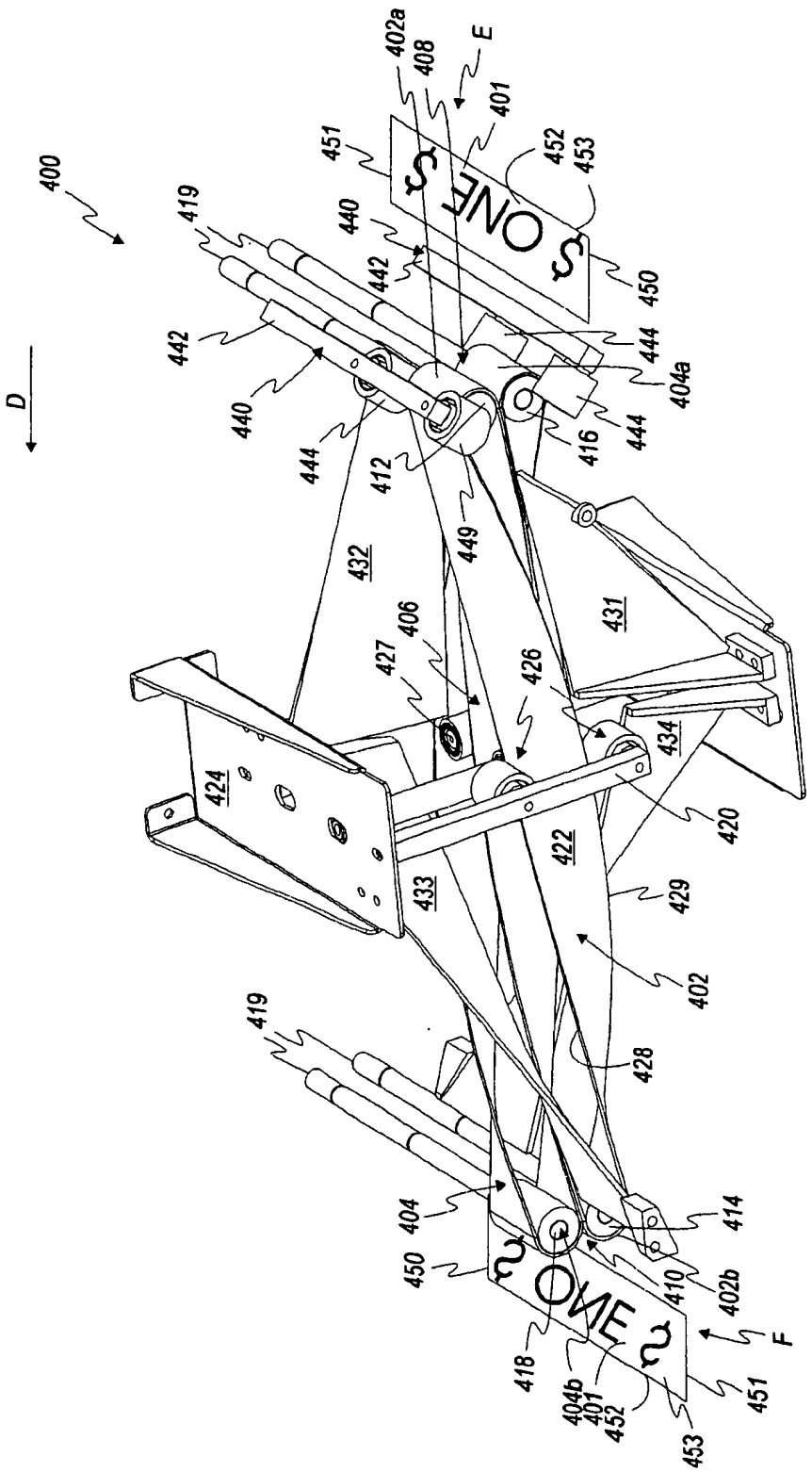
404b
F

FIG. 19

FIG. 20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406
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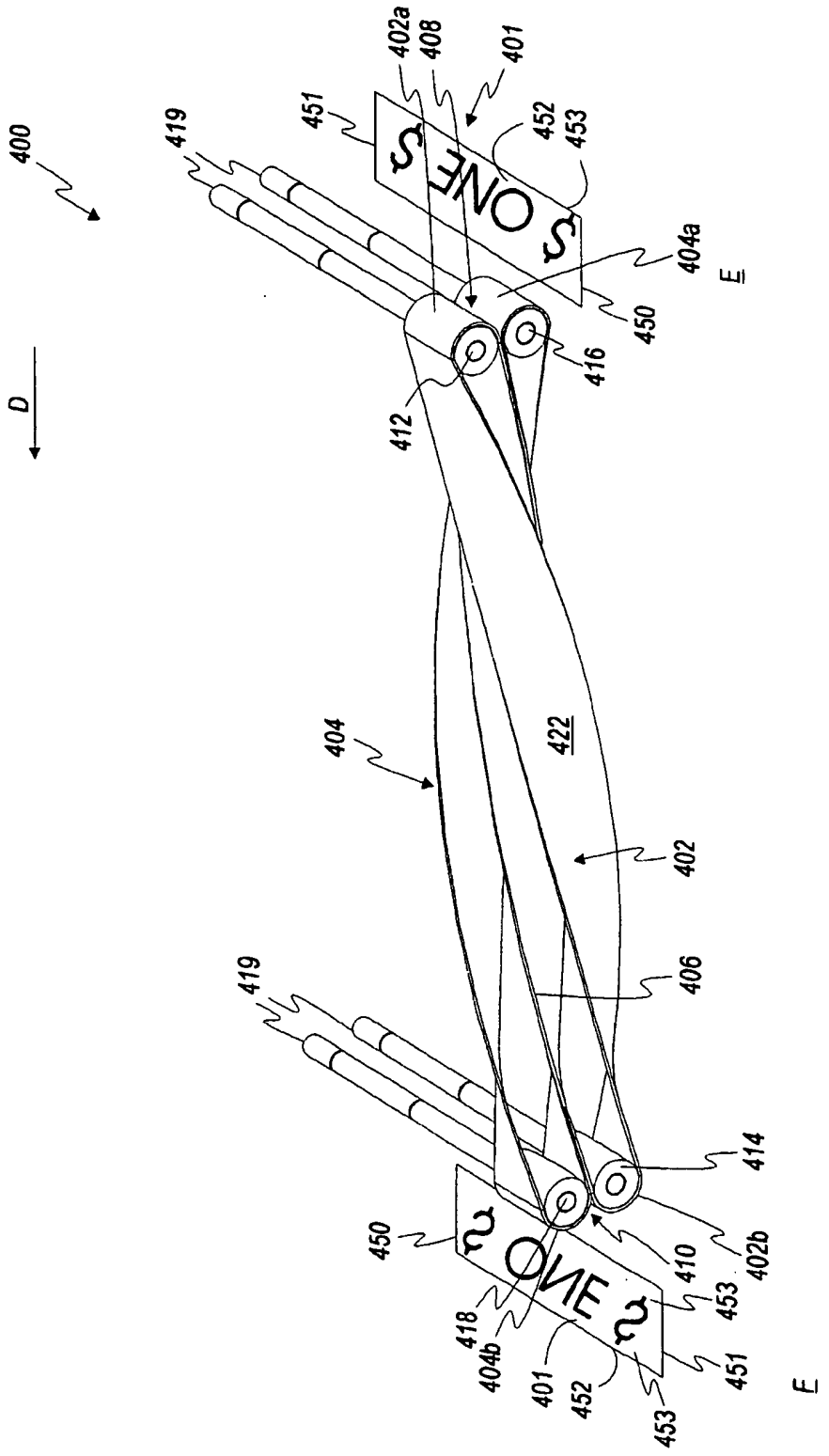
410
402b
F
418
404b
TWO

FIG. 21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D
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402a
408
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422
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TWO
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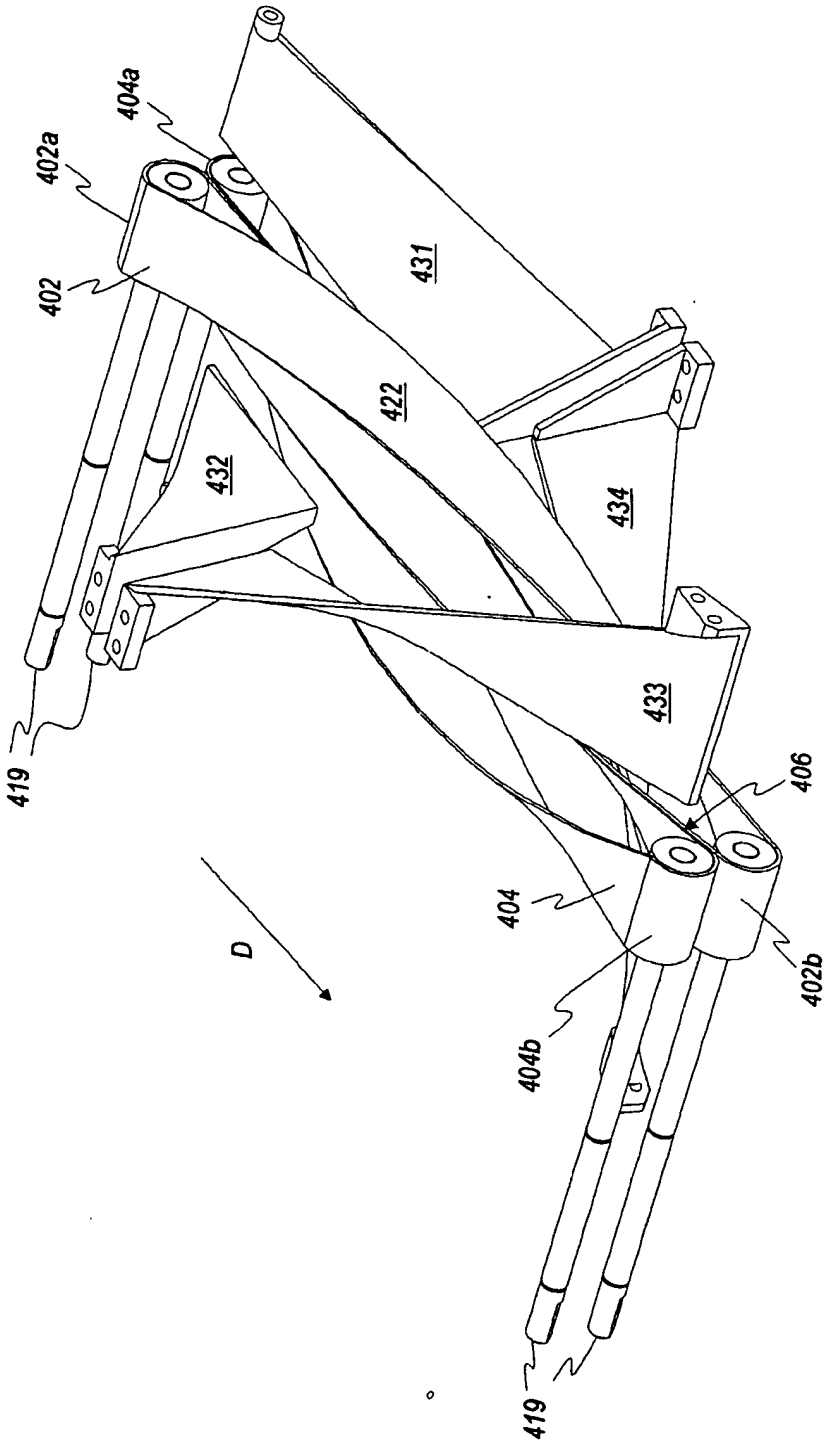
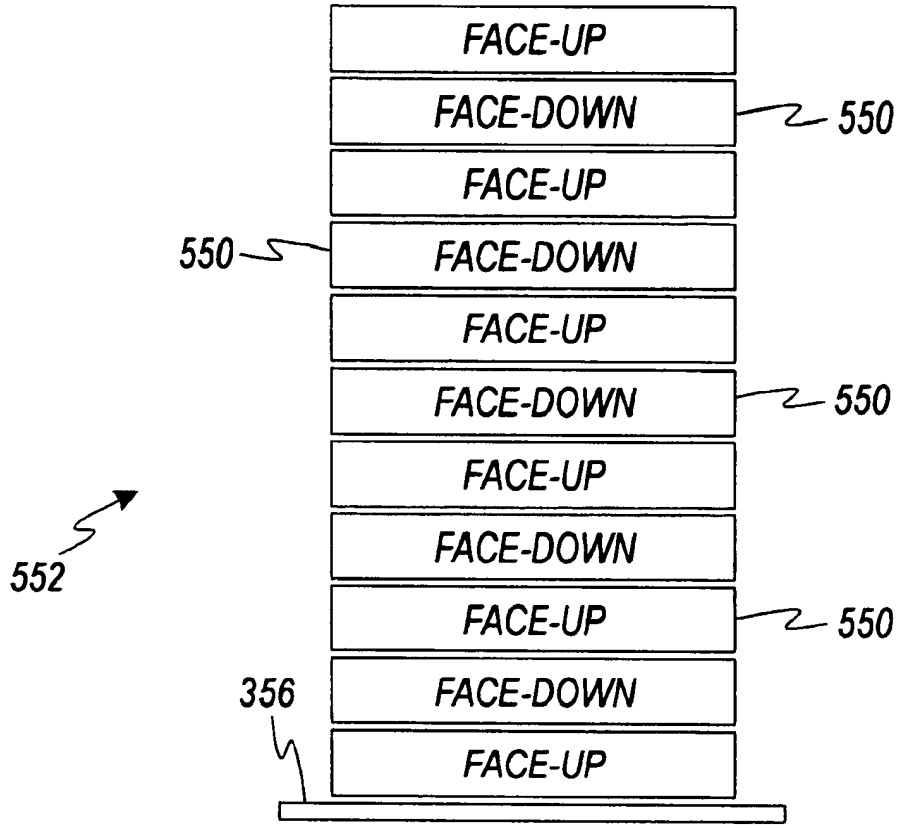
418
404b

FIG. 22

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FACE-DOWN
FACE-UP

FIG. 23

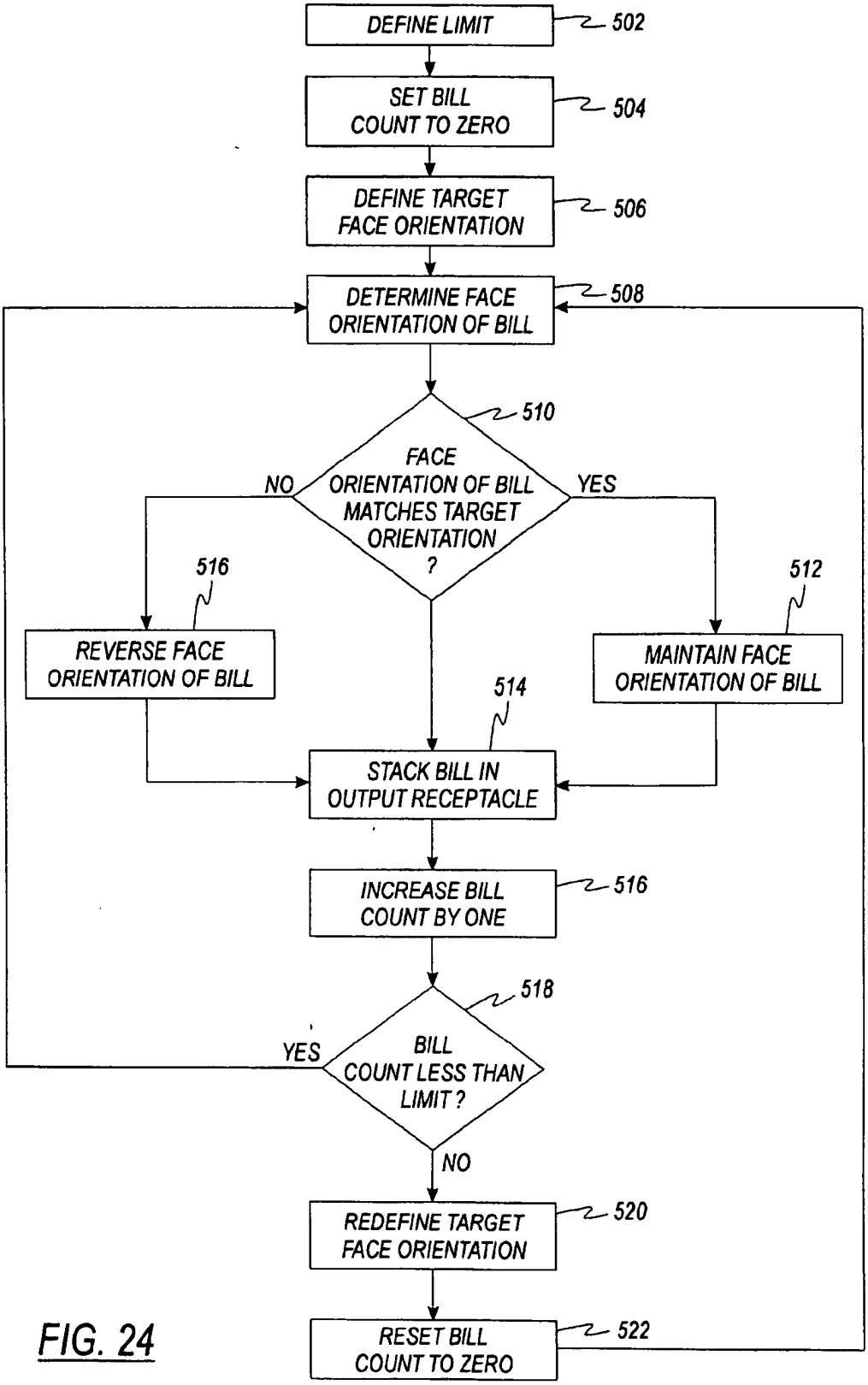
DEFINE LIMIT
502
SET BILL COUNT TO ZERO
504
DEFINE TARGET FACE ORIENTATION
506
DETERMINE FACE ORIENTATION OF BILL
508
510
FACE ORIENTATION OF BILL MATCHES TARGET ORIENTATION ?
NO
YES
516
REVERSE FACE ORIENTATION OF BILL
512
MAINTAIN FACE ORIENTATION OF BILL
514
STACK BILL IN OUTPUT RECEPTACLE
INCREASE BILL COUNT BY ONE
516
518
BILL COUNT LESS THAN LIMIT ?
YES
NO
REDEFINE TARGET FACE ORIENTATION
520
RESET BILL COUNT TO ZERO
522

FIG. 24

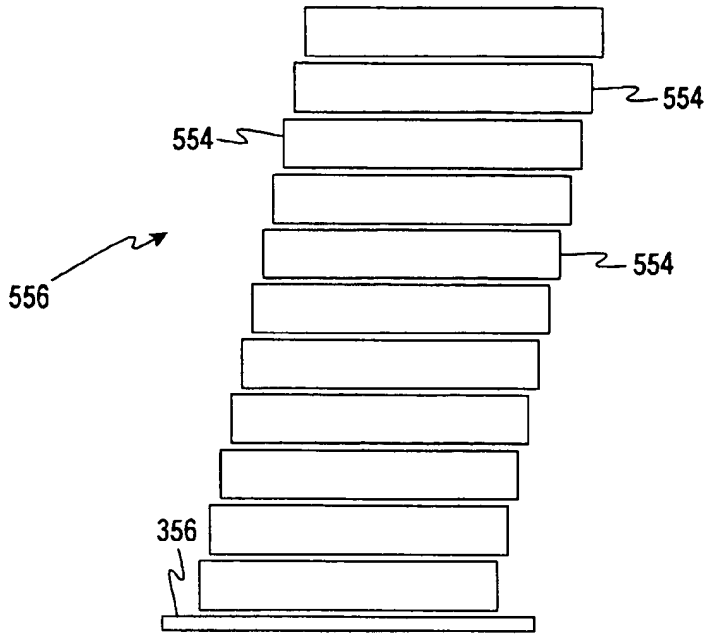

FIG. 25a

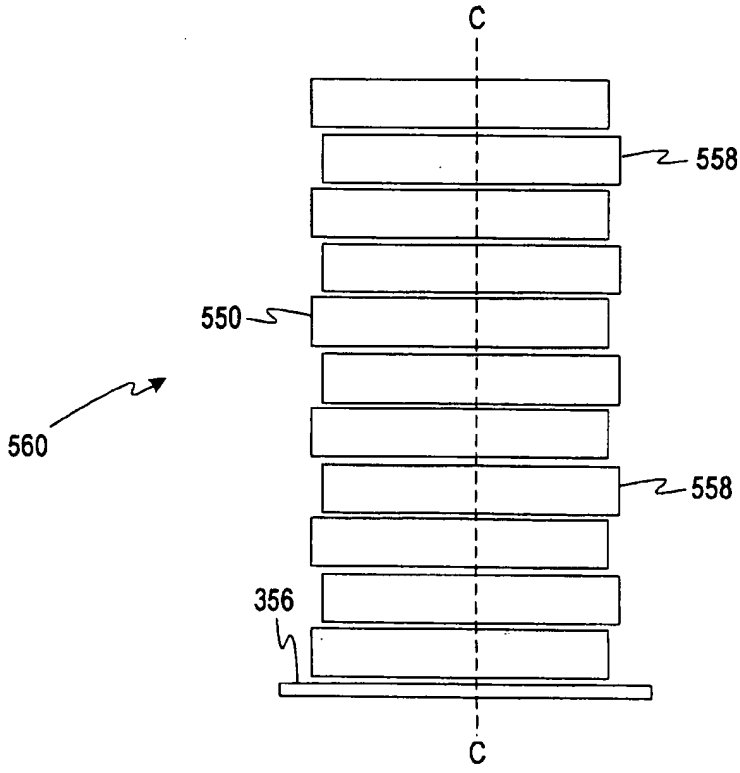

FIG. 25b

METHOD OF CREATING IDENTIFIABLE SMALLER STACKS OF CURRENCY BILLS WITHIN A LARGER STACK OF CURRENCY BILLS

FIELD OF THE INVENTION

The present invention relates generally to the field of currency handling systems and, more particularly, to a method and apparatus for creating identifiable smaller stacks of currency bills within a larger stack of currency bills using a currency handling device.

BACKGROUND OF THE INVENTION

A variety of techniques and apparatuses have been used to satisfy the requirements of automated currency handling machines. As businesses and banks grow, these businesses are experiencing a greater volume of paper currency. These businesses are continually requiring not only that their currency be processed more quickly but, also, processed with more options in a less expensive manner. At the upper end of sophistication in this area of technology are machines that are capable of rapidly identifying, discriminating, and counting multiple currency denominations and then sorting the currency bills into a multitude of output compartments. Further, some of these high-end machines can segregate the processed bills into smaller batches and then bind each of the smaller batches with a paper strap. Many of these high-end machines are extremely large and expensive such that they are commonly found only in large institutions. These machines are not readily available to businesses which have monetary and space budgets, but still have the need to process large volumes of currency. Other high-end currency handling machines require their own climate controlled environment which may place even greater strains on businesses having monetary and space budgets.

Typically, in the handling of bulk currency, after the currency bills have been analyzed, denominated, authenticated, counted and/or otherwise processed, the currency bills are strapped. Bill strapping is a process whereby a stack of a specific number of bills of a single denomination are secured with a paper strap. For example, one dollar bills are segregated into stacks of one-hundred $1 bills and then bound with a paper strap. Strapping facilitates the handling of currency by allowing the strapped stacks of bills to be counted rather than the individual currency bills. Traditionally, U.S. currency bills are strapped in one-hundred bill stacks.

The task of bill strapping can increase the amount of time required to process a given batch of currency. Some currency handing machines are able to segregate currency bills into individual denominations, then the operator must manually count the bills into smaller batches for strapping purposes. In other situations, a currency handling device may suspend operation after a predetermined number of bills of a given denomination have been delivered to an output receptacle at which time the operator can remove those bills from the output receptacle and bind the bills with a paper strap. However, this manner of strapping can increase the time required to process a batch of currency bills. Higher end currency processing machines are capable of strapping bills. However, there is an increased cost associated with these higher end machines.

SUMMARY OF THE INVENTION

According to one embodiment of the present invention there is provided a method and device for identifying small stacks of currency bills within a larger stack of currency bills using a currency evaluation device. A batch of currency bills to be processed are received in an input receptacle and are transported from the input receptacle, one at a time, past an evaluating unit to at least one output receptacle. The evaluating unit determines information concerning each of the bills including the face orientation of each of the bills. Next it is determined whether the face orientation of each of the bills matches a target face orientation. If the face orientation of a bill matches the target orientation, the face orientation of that bill is maintained. If the face orientation of a bill fails to match the target orientation, the face orientation of that bill is reversed with a bill facing mechanism. Each of the bills are then stacked in the output receptacle. After a predetermined number of bills having a common face orientation are stacked in the output receptacle, the target face orientation is redefined. The bills continue to be processed in this manner until each of the bills are transported from the input receptacle.

The above summary of the present invention is not intended to represent each embodiment, or every aspect, of the present invention. Additional features and benefits of the present invention will become apparent from the detail description, figures, and claim set forth below.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects and advantages of the invention will become apparent upon reading the following detailed description in conjunction with the drawings in which:

FIG. 1*a* is a perspective view of a document handling device according to one embodiment of the invention;

FIG. 1*b* is a front view of a document handling device according to one embodiment of the invention;

FIG. 2*a* is a perspective view of an evaluation region according to one embodiment of the document handling device of the present invention;

FIG. 2*b* is a side view of an evaluation region according to one embodiment of the document handling device of the present invention;

FIG. 3*a* is a perspective view of an input receptacle according to one embodiment of the document handling device of the present invention;

FIG. 3*b* is another perspective view of an input receptacle according to one embodiment of the document handling device of the present invention;

FIG. 3*c* is a top view of an input receptacle according to one embodiment of the document handling device of the present invention;

FIG. 3*d* is a side view of an input receptacle according to one embodiment of the document handling device of the present invention;

FIG. 4 is a perspective view of a portion of a transportation mechanism according to one embodiment of the present invention;

FIG. 5 is a front perspective view of an escrow compartment, a plunger assembly, and a storage cassette according to one embodiment of the document handling device of the present invention;

FIG. 6 is a top view of an escrow compartment and plunger assembly according to one embodiment of the document handling device of the present invention;

FIG. 7 is a front view of an escrow compartment and plunger assembly according to one embodiment of the document handling device of the present invention;

FIG. **8** is another front view of an escrow compartment and plunger assembly according to one embodiment of the document handling device of the present invention;

FIG. **9** is a perspective view of an apparatus for transferring currency from an escrow compartment to a storage cassette according to one embodiment of the document handling device of the present invention;

FIG. **10** is a perspective view of a paddle according to one embodiment of the document handling device of the present invention;

FIG. **11** is a rear perspective view of the escrow compartment, plunger assembly, and storage cassette according to one embodiment of the document handling device of the present invention;

FIG. **12** is a rear view of a plunger assembly wherein the gate is in the open position according to one embodiment of the document handling device of the present invention;

FIG. **13** is a rear view of a plunger assembly wherein the gate is in the closed position according to one embodiment of the document handling device of the present invention;

FIG. **14** is a perspective view of a storage cassette according to one embodiment of the document handling device of the present invention;

FIG. **15** is a rear view of a storage cassette according to one embodiment of the document handling device of the present invention;

FIG. **16** is a perspective view of a storage cassette showing a door in the open position according to one embodiment of the document handling device of the present invention;

FIG. **17***a* is a top view of a storage cassette sized to accommodate United States currency documents according to one embodiment of the document handling device of the present invention;

FIG. **17***b* is a rear view of a storage cassette sized to accommodate United States currency documents according to one embodiment of the document handling device of the present invention;

FIG. **18***a* is a top view of a storage cassette sized to accommodate large documents according to one embodiment of the document handling device of the present invention;

FIG. **18***b* is a rear view of a storage cassette sized to accommodate large documents according to one embodiment of the document handling device of the present invention;

FIG. **19** is a perspective view of a two belt bill facing mechanism according to one embodiment of the present invention;

FIG. **20** is another perspective view of a two belt bill facing mechanism according to one embodiment of the document handling device of the present invention;

FIG. **21** is a perspective view of a two belt bill facing mechanism without belt guides or bill guides according to one embodiment of the document handling device of the present invention;

FIG. **22** is a perspective view of a two belt bill facing mechanism without belt guides according to one embodiment of the document handling device of the present invention; and

FIG. **23** is a front view of a stack of currency bills stacked pursuant to a strapping mode of operation according to one embodiment of the present invention;

FIG. **24** is a flow charting illustrating the steps performed when operating pursuant to a strapping mode of operation according to one embodiment of the present invention;

FIG. **25***a* is a front view of a stack of currency bills stacked pursuant to a strapping mode of operation according to one embodiment of the present invention; and

FIG. **25***b* is a front view of a stack of currency bills stacked pursuant to a strapping mode of operation according to one embodiment of the present invention.

DETAILED DESCRIPTION OF THE ILLUSTRATED EMBODIMENTS

Referring to FIGS. **1***a* and **1***b*, a multi-pocket document processing device **100** such as a currency handling device according to one embodiment of the present invention is illustrated. Currency bills are fed, one by one, from a stack of currency bills placed in an input receptacle **102** into a transport mechanism **104**. The transport mechanism **104** guides currency bills to one of a plurality of output receptacles **106***a*–**106***h*, which may include upper output receptacles **106***a*, **106***b*, as well as lower output receptacles **106***c*–**106***h*. Before reaching an output receptacle **106** the transport mechanism **104** guides the bill through an evaluation region **108** where a bill can be, for example, analyzed, authenticated, denominated, counted, and/or otherwise processed. In alternative embodiments of the currency handling device **100** of the present invention, the evaluation region **108** can determine bill orientation, bill size, or whether bills are stacked upon one another. The results of the above process or processes may be used to determine to which output receptacle **106** a bill is directed. The illustrated embodiment of the currency handling device has an overall width, W_1, of approximately 4.52 feet (1.38 meters), a height, H_1, of approximately 4.75 feet (1.45 meters), and a depth, D_1, of approximately 1.67 feet (0.50 meters).

In one embodiment, documents such as currency bills are transported, scanned, denominated, authenticated and/or otherwise processed at a rate equal to or greater than 600 bills per minute. In another embodiment, documents such as currency bills are transported, scanned, denominated, authenticated, and/or otherwise processed at a rate equal to or greater than 800 bills per minute. In another embodiment, documents such as currency bills are transported, scanned, denominated, authenticated and/or otherwise processed at a rate equal to or greater than 1000 bills per minute. In still another embodiment, documents such as currency bills are transported, scanned, denominated, authenticated, and/or otherwise processed at a rate equal to or greater than 1200 bills per minute.

In the illustrated embodiment, interposed in the bill transport mechanism **104**, intermediate the bill evaluation region **108** and the lower output receptacles **106***c*–**106***h* is a bill facing mechanism designated generally by reference numeral **110**. The bill facing mechanism is capable of rotating a bill 180° so that the face orientation of the bill is reversed. The leading edge of the bill (the wide dimension of the bill according to one embodiment) remains constant while the bill is rotated 180° about an axis parallel to the smaller dimension of the bill) so that the face orientation of the bill is reversed. That is, if a U.S. bill, for example, is initially presented with the surface bearing a portrait of a president facing down, it may be directed to the facing mechanism **110**, whereupon it will be rotated 180° so that the surface with the portrait faces up. The decision may be taken to send a bill to the facing mechanism **110** when the selected mode of operation or other operator instructions call for maintaining a given face orientation of bills as they are processed by the currency handling device **100**. Using U.S. currency as an example, it may be desirable in certain

circumstances for all of the bills ultimately delivered to the lower output receptacles **106***c*–**106***h* to have the bill surface bearing the portrait of the president facing up. In such embodiments of the currency handling device **100**, the bill evaluation region **108** is capable of determining the face orientation of a bill, such that a bill not having the desired face orientation can first be directed to the facing mechanism **110** before being delivered to the appropriate output receptacle **106**. Further details of a facing mechanism which may be utilized for this purpose are disclosed in commonly-owned, co-pending U.S. application Ser. No. 09/181,254, entitled "Document Facing Method and Apparatus" which was filed on Oct. 28, 1998, incorporated herein by reference in its entirety, which may be employed in conjunction with the present invention such as the device illustrated in FIGS. **1***a* and **1***b*. Other alternative embodiments of the currency handling device **100** do not include the facing mechanism **110**.

The currency handling device **100** in FIG. **1***a* may be controlled from a separate controller or control unit **120** which has a display/user-interface **122**, which may incorporate a touch panel display in one embodiment of the present invention, which displays information, including "functional" keys when appropriate. The display/user-interface **122** may be a full graphics display. Alternatively, additional physical keys or buttons, such as a keyboard **124**, may be employed. The control unit **120** may be a self-contained desktop or laptop computer which communicates with the currency handling device **100** via a cable **125**. The currency handling device **100** may have a suitable communications port (not shown) for this purpose. In embodiments in which the control unit **120** is a desktop computer wherein the display/user-interface **122** and the desktop computer are physically separable, the desktop computer may be stored within a compartment **126** of the currency handling device **100**. In other alternative embodiments, the control unit **120** is integrated into the currency handling device **100** so the control unit **120** is contained within the device **100**.

The operator can control the operation of the currency handling device **100** through the control unit **120**. Through the control unit **120** the operator can direct the bills into specific output receptacles **106***a*–**106***h* by selecting various user defined modes. In alternative embodiments, the user can select pre-programmed user defined modes or create new user defined modes based on the particular requirements of the application. For example, the operator may select a user defined mode which instructs the currency handling device **100** to sort bills by denomination; accordingly, the evaluation region **108** would denominate the bills and direct one dollar bills into the first lower output receptacle **106***c*, five dollar bills into the second lower output receptacle **106***d*, ten dollar bills into the third lower output receptacle **106***e*, twenty dollar bills into the forth lower output receptacle **106***f*, fifty dollar bills into the fifth lower output receptacle **106***g*, and one-hundred dollar bills into the sixth lower output receptacle **106***h*. The operator may also instruct the currency handling device **100** to deliver those bills whose denomination was not determined, no call bills, to the first upper output receptacle **106***a*. In such an embodiment, upper output receptacle **106***a* would function as a reject pocket. In an alternative embodiment, the operator may instruct the currency handling device **100** to also evaluate the authenticity of each bill. In such an embodiment, authentic bills would be directed to the appropriate lower output receptacle **106***c*–**106***h*. Those bills that were determined not to be authentic, suspect bills, would be delivered to the second upper output receptacle **106***b*. A multitude of user defined modes are disclosed by co-pending U.S. patent application Ser. No. 08/916,100 entitled "Multi-Pocket Currency Discriminator" which was filed on Aug. 21, 1997, incorporated herein by reference in its entirety, which may be employed in conjunction with the present invention such as the device illustrated in FIGS. **1***a* and **1***b*.

According to one embodiment, the currency handling device **100** is designed so that when the evaluation region **108** is unable to identify certain criteria regarding a bill, the unidentified bill is flagged and "presented" in one of the output receptacles **106***a*–**106***h*, that is, the transport mechanism **104** is stopped so that the unidentified bill is located at a predetermined position within one of the output receptacles **106***a*–**106***h*, such as being the last bill transported to one of the output receptacles. Such criteria can include denominating information, authenticating information, information indicative of the bill's series, or other information the evaluation region **108** is attempting to obtain pursuant to a mode of operation. Which output receptacles **106***a*–**106***h* the flagged bill is presented in may be determined by the user according to a selected mode of operation. For example, where the unidentified bill is the last bill transported to an output receptacle **106***a*–**106***h*, it may be positioned within a stacker wheel or positioned at the top of the bills already within the output receptacle **106***a*–**106***h*. While unidentified bills may be transported to any output receptacles **106***a*–**106***h*, it may be more convenient for the operator to have unidentified bills transported to one of the upper output receptacles **106***a,b* where the operator is able to easily see and/or inspect the bill which has not been identified by the evaluation region **108**. The operator may then either visually inspect the flagged bill while it is resting on the top of the stack, or alternatively, the operator may decide to remove the bill from the output receptacle **106** in order to examine the flagged bill more closely. In an alternative embodiment of the currency handling device **100**, the device **100** may communicate to the user via the display/user-interface **122** in which one of the output receptacles **106***a*–**106***h* a flagged bill is presented.

The currency handling device **100** may be designed to continue operation automatically when a flagged bill is removed from the upper output receptacle **106***a,b* or, according to one embodiment of the present invention, the device **100** may be designed to suspend operation and require input from the user via the control unit **120**. Upon examination of a flagged bill by the operator, it may be found that the flagged bill is genuine even though it was not identified as so by the evaluation region **108** or the evaluation region **108** may have been unable to denominate the flagged bill. However, because the bill was not identified, the total value and/or denomination counters will not reflect its value. According to one embodiment, such an unidentified bill is removed from the output receptacles **106** and reprocessed or set aside. According to another embodiment, the flagged bills may accumulate in the upper output receptacles **106***a,b* until the batch of currency bills currently being processed is completed or the output receptacle **106***a,b* is full and then reprocessed or set aside.

According to another embodiment, when a bill is flagged, the transport mechanism may be stopped before the flagged bill is transported to one of the output receptacles. Such an embodiment is particularly suited for situations in which the operator need not examine the bill being flagged; for example, the currency handling device **100** is instructed to first process United States currency and then British currency pursuant to a selected mode of operation where the currency handling device **100** processes United States $1,

$5, $10, $20, $50, and $100 currency bills into the lower output receptacles **106***c*–**106***h*, respectively. Upon detection of the first British pound note, the currency handling device **100** may halt operation allowing the operator to empty the lower output receptacles **106***c*–**106***h* and to make any spatial adjustments necessary to accommodate the British currency. A multitude of modes of operation are described in conjunction with bill flagging, presenting, and/or transport halting in commonly owned, co-pending U.S. patent application Ser. No. 08/916,100 entitled "Method and Apparatus for Document Processing" which was filed on May 28, 1997, incorporated herein by reference in its entirety above, which may be employed in conjunction with the present invention such as the device illustrated in FIGS. **1***a* and **1***b*.

In the illustrated embodiment, with regard to the upper output receptacles **106***a*, **106***b*, the second upper output receptacle **106***b* is provided with a stacker wheel **127** for accumulating a number of bills, while the first upper output receptacle **106***a* is not provided with such a stacker wheel. Thus, when pursuant to a preprogrammed mode of operation or an operator selected mode or other operator instructions, a bill is to be fed to the first upper output receptacle **106***a*, there may be a further instruction to momentarily suspend operation of the currency handling device **100** for the operator to inspect and remove the bill. On the other hand, it may be possible to allow a small number of bills to accumulate in the first upper output receptacle **106***a* prior to suspending operation. Similarly, the second upper output receptacle **106***b* may be utilized initially as an additional one of the lower output receptacles **106***c*–**106***h*. However, there is no storage cassette associated with the second upper output receptacle **106***b*. Therefore, when the second upper output receptacle **106***b* is full, operation may be suspended to remove the bills at such time as yet further bills are directed to the second upper output receptacle **106***b* in accordance with the selected mode of operation or other operator instructions. In an alternative embodiment of the currency handling device **100** both the first and the second upper output receptacles **106***a*, **106***b* are equipped with a stacker wheel. In such an embodiment both the upper output receptacles **106***a,b* may also function as the lower output receptacle **106***c*–**106***h* allowing a number of bills to be stacked therein.

FIGS. **2***a* and **2***b* illustrate the evaluation region **108** according to one embodiment of the currency handling system **100**. The evaluation region can be opened for service, access to sensors, clear bill jams, etc. as shown in FIG. **2***a*. The characteristics of the evaluation region **108** may vary according to the particular application and needs of the user. The evaluation region **108** can accommodate a number and variety of different types of sensors depending on a number of variables. These variables are related to whether the machine is authenticating, counting, or discriminating denominations and what distinguishing characteristics are being examined, e.g. size, thickness, color, magnetism, reflectivity, absorbabilty, transmissivity, electrical conductivity, etc. The evaluation region **108** may employ a variety of detection means including, but not limited to, a size detection and density sensor **408**, a lower **410** and an upper **412** optical scan head, a single or multitude of magnetic sensors **414**, a thread sensor **416**, and an ultraviolet/fluorescent light scan head **418**. These detection means and a host of others are disclosed in commonly owned, co-pending U.S. patent application Ser. No. 08/916,100 entitled "Multi-Pocket Currency Discriminator," incorporated by reference above.

The direction of bill travel through the evaluation region **108** is indicated by arrow A. The bills are positively driven along a transport plate **400** through the evaluation region **108** by means of a transport roll arrangement comprising both driven rollers **402** and passive rollers **404**. The rollers **402** are driven by a motor (not shown) via a belt **401**. Passive rollers **404** are mounted in such a manner as to be free-wheeling about their respective axis and biased into counter-rotating contact with the corresponding driven rollers **402**. The driven and passive rollers **402**, **404** are mounted so that they are substantially coplanar with the transport plate **400**. The transport roll arrangement also includes compressible rollers **406** to aid in maintaining the bills flat against the transport plate **400**. Maintaining the bill flat against the transport plate **400** so that the bill lies flat when transported past the sensors enhances the overall reliability of the evaluation processes. A similar transport arrangement is disclosed in commonly-owned U.S. Pat. No. 5,687,963 entitled "Method and Apparatus for Discriminating and Counting Documents," which is incorporated herein by reference in its entirety.

Referring now to FIGS. **3***a*–**3***d*, the input receptacle **102** of the currency handling device **100** is illustrated. A feeder mechanism such as a pair of stripping wheels **140** aid in feeding the bills in seriatim to the transport mechanism **104** which first carries the bills through the evaluation region **108**. According to one embodiment, the input receptacle **102** includes at least one spring-loaded feeder paddle **142***a* which is pivotally mounted, permitting it to be pivoted upward and drawn back to the rear of a stack of bills placed in the input receptacle **102** so as to bias the bills towards the evaluation region **108** via the pair of stripping wheels **140**. The paddle **142***a* is coupled to an advance mechanism **144** to urge the paddle **142***a* towards the stripping wheels **140**. In the illustrated embodiment, motion is imparted to the advance mechanism via a spring **145**. In other alternative embodiments, the advance mechanism **144** is motor driven. The advance mechanism **144** is slidably mounted to a shaft **146**. The advance mechanism **144** also constrains the paddle **142***a* to a linear path. The advance mechanism **144** may contain a liner bearing (not shown) allowing the paddle **142***a* to easily slide along the shaft **146**. In the embodiment illustrated, the paddle **142***a* may also contain channels **148** to aid in constraining the paddle **142***a* to a linear path along a pair of tracks **150**. The paddle **142***a* may additionally include a roller **152** to facilitate the movement of the paddle **142***a*.

In the embodiment illustrated in FIGS. **3***a*–**3***d*, a second paddle **142***b* is provided such that a second stack of bills **147** may be placed in the input receptacle **102** behind a first group of bills **149**, while the first group of bills **149** is being fed into the currency handling device **100**. Thus, the two feeder paddles **142***a* and **142***b* may be alternated during processing in order to permit multiple stacks of currency bills to be loaded into the input receptacle **102**. In such an embodiment, the operator would retract paddle **142***a* and place a stack of bills into the input receptacle. Once inside the input receptacle, the operator would place the paddle **142***a* against the stack of bills so that the paddle **142***a* biases the stack of bills towards the pair of stripper wheels **140**. The operator could then load a second stack of bills into the input receptacle **102** by retracting the second paddle **142***b* and placing a stack of bills in the input receptacle between the paddles **142***a* and **142***b*. The second paddle **142***b* urges the second stack of bills up against the backside of the first paddle **142***a*. The operator can then upwardly rotate the first paddle **142***a* thus combining the two stacks. The first paddle **142***a* is then retracted to the rear of the input receptacle and the process can be repeated. The two paddle input receptacle

allows the operator to more easily continuously feed stacks of bills to the currency handling device **100**. In devices not having two feeder paddles, the operator is forced to awkwardly manipulate the two stacks of bills and the advance mechanism. Alternatively, the operator may wait for the stack of bills to be processed out of the input receptacle to add another stack, however, waiting to reload until each stack is processed adds to the total time to process a given amount of currency.

Referring to FIG. **4**, a portion of the transport mechanism **104** and diverters **130***a*–**130***d* are illustrated. A substantial portion of the transport path of the currency handling device **100** positively grips the bills during transport from the pair of stripping wheels **140** through the point where bills are delivered to upper output receptacle **106***a* or are delivered to the stacker wheels **202** of output receptacles **106***b*–**106***h*. The positive grip transport path of the currency handling device **100** is less costly and weighs less than the vacuum transport arrangements of other currency processing devices.

The transport mechanism **104** is electronically geared causing all sections to move synchronously from the evaluation region **108** through the point where the bills are delivered to the output receptacles **106**. Multiple small motors are used to drive the transport mechanism **104**. Using multiple small, less costly motors is more efficient and less costly than a single large motor. Further, less space is consumed enabling the currency handling device **100** to be more compact. Electronically gearing the transport mechanism **104** enables a single encoder to monitor bill transportation within the currency handling system **100**. The encoder is linked to the bill transport mechanism **104** and provides input to a processor to determine the timing of the operations of the currency handling device **100**. In this manner, the processor is able to monitor the precise location of the bills as they are transported through the currency handling device **100**. This process is termed "flow control." Input from additional sensors **119** located along the transport mechanism **104** of the currency handling device **100** enables the processor to continually update the position of a bill within the device **100** to accommodate for bill slippage. When a bill leaves the evaluation region **108** the processor expects the bill to arrive at the diverter **130***a* corresponding to the first lower output receptacle **106***c* after a precise number of encoder counts. Specifically, the processor expects the bill to flow past each sensor **119** positioned along the transport mechanism **104** at a precise number of encoder counts. If the bill slips during transport but passes a sensor **119** later within an acceptable number of encoder counts the processor updates or "re-queues" the new bill position. The processor calculates a new figure for the time the bill is expected to pass the next sensor **119** and arrive at the first diverter **130***a*. The processor activates a the one of the diverters **130***a*–*f* to direct the bill into the appropriate corresponding lower output receptacle **106***c*–**106***h* when the sensor **119** immediately preceding the diverter **130** detects the passage of the bill to be directed into the appropriate lower output receptacle **106***c*–*h*.

The currency handling device **100** also uses flow control to detect jams within the transport mechanism **104** of the device **100**. When a bill does not reach a sensor **119** within in the calculated number of encoder counts plus the maximum number of counts allowable for slippage, the processor suspends operation of the device **100** and informs the operator via the display/user-interface **122** that a jam has occurred. The processor also notifies the operator via the display/user-interface **122** of the location of the jam by indicating the last sensor **119** that the bill passed and generally the approximate location of the jam in the system. If the operator cannot easily remove the bill without damage, the operator can then electronically jog the transport path in the forward or reverse direction via the control unit **120** so that the jammed bill is dislodged and the operator can easily remove the bill from the transport path. The operator can then flush the system causing the transport mechanism **104** to deliver all of the bills currently within the transport path of the currency handling device **100** to one of the output receptacles **106**. In an alternative embodiment, the user of the currency handling device **100** would have the option when flushing the system to first have the bills already within the escrow regions **116***a*–**116***f* to be delivered to the respective lower storage cassettes **106***c*–**106***h* so that those bills may be included in the aggregate value data for the bills being processed. The bills remaining in the transport path **104** would then be delivered to a predetermined escrow region **116** where those bills could be removed and reprocessed by placing those bills in the input receptacle **102**.

Utilizing flow control to detect jams is more desirable than prior art currency evaluation machines which do not detect a jam until a sensor is actually physically blocked. The latter method of jam detection permits bills to pile up while waiting for a sensor to become blocked. Bill pile-up is problematic because it may physically halt the machine before the jam is detected and may cause physical damage to the bills and the machine. In order to remedy a jam in a prior art machine, the operator must first manually physically dislodge the jammed bills. The operator must then manually turn a hand crank which advances the transport path until all bills within the transport path are removed. Moreover, because the prior art devices permit multiple bills to pile up before a jam is detected, the integrity of the process is often ruined. In such a case, the entire stack of bills must be reprocessed.

Referring back to FIG. **1***a*, the illustrated embodiment of the currency handling device **100** includes a total of six lower output receptacles **106***c*–**106***h*. More specifically, each of the lower output receptacles **106***c*–**106***h* includes a first portion designated as an escrow compartment **116***a*–**116***f* and a second portion designated as a storage cassette **118***a*–**118***f*. Typically, bills are initially directed to the escrow compartments **116**, and thereafter at specified times or upon the occurrence of specified events, which may be selected or programmed by an operator, bills are then fed to the storage cassettes **118**. The storage cassettes are removable and replaceable, such that stacks of bills totaling a predetermined number of bills or a predetermined monetary value may be accumulated in a given storage cassette **118**, whereupon the cassette may be removed and replaced with an empty storage cassette. In the illustrated embodiment, the number of lower output receptacles **106***c*–**106***h* including escrow compartments **116** and storage cassettes **118** are six in number. In alternative embodiments, the currency handling device **100** may contain more or less than six lower output receptacles including escrow compartments and storage cassettes **118**. In other alternative embodiments, modular lower output receptacles **106** can be implemented to add many more lower output receptacles to the currency handling system **100**. Each modular unit may comprise two lower output receptacles. In other alternative embodiments, several modular units may be added at one time to the currency handling device **100**.

A series of diverters **130***a*–**130***f*, which are a part of the transportation mechanism **104**, direct the bills to one of the lower output receptacles **106***c*–**106***h*. When the diverters **130**

are in an upper position, the bills are directed to the adjacent lower output receptacle **106**. When the diverters **130** are in a lower position, the bills proceed in the direction of the next diverter **130**.

The vertical arrangement of the lower output receptacles **106***c*–**106***h* is illustrated in FIG. **5**. The escrow compartment **116** is positioned above the storage cassette **118**. In addition to the escrow compartment **116** and the storage cassette **118**, each of the lower output receptacles **106***c*–**106***h* contains a plunger assembly **300**. The plunger assembly **300** is shown during its decent towards the storage cassette **118**.

Referring now to FIGS. **6** and **7**, one of the escrow compartments **116** of the lower output receptacles **106***c*–**106***h* is shown. The escrow compartment **116** contains a stacker wheel **202** to receive the bills **204** from the diverter **130**. The stacker wheel **202** stacks the bills **204** within the escrow compartment walls **206**, **208** on top of a gate **210** disposed between the escrow compartment **116** and the storage cassette **118**. In an alternative embodiment, the escrow compartment **116** contains a pair of guides to aid in aligning the bills substantially directly on top of one another. The gate **210** is made up of two shutters: a first shutter **211** and a second shutter **212**. The shutters **211**, **212** are hingedly connected enabling the shutters **211**, **212** to rotate downward approximately ninety degrees to move the gate from a first position (closed position) wherein the shutters **211**, **212** are substantially co-planer to a second position (open position) wherein the shutters **211**, **212** are substantially parallel. Below the gate **210** is the storage cassette **118** (not shown in FIGS. **6** and **7**).

FIG. **8** illustrates the positioning of the paddle **302** when transferring a stack of bills from the escrow compartment **116** to the storage cassette **118**. When the paddle descends upon the stack of bills **204** it causes shutters **211**, **212** to quickly rotate in the directions referred to by arrows B and C, respectively; thus, "snapping" open the gate **210**. The quick rotation of the shutters **211**, **212** insures that the bills fall into the storage cassette **118** in a substantially stacked position. According to one embodiment, the paddle is programmed to descend after a predetermined number of bills **204** are stacked upon the gate **210**. According to other embodiments, the operator can instruct the paddle **302** via the control unit **120** to descend upon the bills **204** stacked upon the gate **210**.

Referring now to FIG. **9**, the plunger assembly **300** for selectively transferring the bills **204** from an escrow compartment **116** to a corresponding storage cassette **118** and the gate **210** are illustrated in more detail. One such plunger assembly **300** is provided for each of the six lower output receptacles **106***c*–**106***h* of the currency handling device **100**. The plunger assembly **300** comprises a paddle **302**, a base **304**, and two side arms **306**, **308**. Each of the shutters **211**, **212** comprising the gate **210** extends inwardly from corresponding parallel bars **214**, **215**. The bars **214**, **215** are mounted for pivoting the shutters between the closed position and the open position. Levers **216**, **217** are coupled to the parallel bars **214**, **215**, respectively, to control the rotation of the bars **214**, **215** and hence of the shutters **211**, **212**. Extension springs **218**, **219** (shown in FIG. **8**) tend to maintain the position of the levers **216**, **217** both in the closed and open positions. The shutters **211**, **212** have an integral tongue **213***a* and groove **213***b* arrangement which prevents any bills which are stacked upon the gate **210** from slipping between the shutters **211**, **212**.

The base **304** travels along a vertical shaft **311** with which it is slidably engaged. The base **304** may include linear bearings (not shown) to facilitate its movement along the vertical shaft **311**. The plunger assembly **300** may also include a vertical guiding member **312** (see FIG. **11**) with which the base **304** is also slidably engaged. The vertical guiding member **312** maintains the alignment of the plunger assembly **300** by preventing the plunger assembly **300** from twisting laterally about the vertical shaft **311** when the paddle **302** forces the bills **204** stacked in the escrow area **116** down into a storage cassette **118**.

Referring also to FIG. **10**, the paddle **302** extends laterally from the base **304**. The paddle **302** is secured to a support **314** extending from the base **304**. A pair of side arms **306**, **308** are hingedly connected to the base. Each of the side arms **306**, **308** protrude from the sides of the base **304**. Rollers **316**, **318** are attached to the side arms **306**, **308**, respectively, and are free rolling. Springs **313***a*, **313***b* are attached to the side arms **306**, **308**, respectively, to bias the side arms **306**, **308** outward from the base **304**. In the illustrated embodiment, the spring **313***a*, **313***b* are compression springs.

The paddle **302** contains a first pair of slots **324** to allow the paddle to clear the stacker wheel **202** when descending into and ascending out of the cassette **118**. The first pair of slots **324** also enables the paddle **302** to clear the first pair of retaining tabs **350** within the storage cassette (see FIG. **14**). Similarly, paddle **302** contains a second pair of slots **326** to enable the paddle **302** to clear the second pair of retaining tabs **350** within the storage cassette **118** (see FIG. **14**).

Referring now to FIG. **11**, which illustrates a rear view of one of the lower output receptacles **106***c*–**106***h*, the plunger **300** is bidirectionally driven by way of a belt **328** coupled to an electric motor **330**. A clamp **332** engages the belt **328** into a channel **334** in the base **304** of the plunger assembly **300**. In the embodiment illustrated in FIG. **11**, two plunger assemblies **300** are driven by a single electric motor **330**. In one embodiment of the currency handling device, the belt **328** is a timing belt. In other alternative embodiments, each plunger assembly **300** can be driven by a single electric motor **330**. In still other alternative embodiments, there can be any combination of motors **330** to plunger assemblies **300**.

FIGS. **12** and **13** illustrate the interaction between the side arms **306**, **308** and the levers **216**, **217** when the paddle assembly **300** is descending towards and ascending away from the storage cassette **118**, respectively. Initially, before descending towards the cassette, the shutters are in a first (closed) position. In the illustrated embodiment, it is the force imparted by the paddle **302** which opens the gate **210** when the paddle descends towards the storage cassette **118**. When the paddle is ascending away from the storage cassette **119**, it is the rollers **316**, **318** coupled to the side arms **306**, **308** which engage the levers **216**, **217** that close the gate **210**. The levers **216**, **217** shown in FIG. **12** are positioned in the open position. When descending towards the storage cassette **118**, the rollers **316**, **318** contact the levers **216**, **217** and roll around the levers **216**, **217** leaving the shutters in the open position. The side arms **306**, **308** are hinged in a manner which allows the side arms **306**, **308** to rotate inward towards the base **304** as the rollers **316**, **318** engage the levers **216**, **217**. FIG. **13** illustrates the levers in the second position wherein the gate **210** is closed. When the paddle ascends out of the storage cassette, the side arms **306**, **308** are biased away from the base **304**. The rollers **316**, **318** engage the levers **216**, **217** causing the levers to rotate upward to the first position thus closing the gate.

FIGS. **14**, **15**, and **16** illustrate the components of the storage cassettes **118**. The bills **204** are stored within the

cassette housing **348** which has a base **349**. Each storage cassette **118** contains two pairs of retaining tabs **350** positioned adjacent to the interior walls **351, 352** of the storage cassette. The lower surface **354** of each tab **350** is substantially planar. The tabs **350** are hingedly connected to the storage cassette **118** enabling the tabs **350** to downwardly rotate from a horizontal position, substantially perpendicular with the side interior walls **351, 352** of the cassette **118**, to a vertical position, substantially parallel to the interior walls **351, 352** of the cassette **118**. The tabs **350** are coupled to springs (not shown) to maintain the tabs in the horizontal position.

The storage cassette **118** contains a slidable platform **356** which is biased upward. During operation of the currency handling system **100**, the platform **356** receives stacks of bills from the escrow compartment **116**. The floor **356** is attached to a base **358** which is slidably mounted to a vertical support member **360**. The base **358** is spring-loaded so that it is biased upward and in turn biases the platform **356** upward. The storage cassettes **118** are designed to be interchangeable so that once full, a storage cassette can be easily removed from the currency handling device **100** and replaced with an empty storage cassette **118**. In the illustrated embodiment, the storage cassette **118** is equipped with a handle **357** in order to expedite removal and/or replacement of the storage cassettes **118**. Also in the illustrated embodiment, the storage cassette **118** has a door **359** which enables an operator to remove bills from the storage cassette **118**

The storage cassettes **118** are dimensioned to accommodate documents of varying sizes. In the illustrated embodiment, the storage cassettes **118** has a height, H_2, of approximately 15.38 inches (39 cm), a depth, D_2, of approximately 9 inches (22.9 cm), and a width, W_2, of approximately 5.66 inches (14.4 cm). The storage cassette illustrated in FIG. **15** has stand-offs **362** to set interior wall **352** off a fixed distance from in the interior wall **353** of the cassette housing **348**. The interior walls **351, 352** aid in aligning the bills in a stack within the storage cassettes. The embodiment of the storage cassette illustrate in FIG. **15** is sized to accommodate United States currency documents. To properly accommodate United States currency documents, the interior width of the storage cassette, W_3, is approximately 2.88 inches. FIGS. **17***a* and **17***b* also illustrate an embodiment of the storage cassette **118** sized to accommodate U.S. currency documents which have a width of approximately 2.5 inches (approximately 6.5 cm) and a length of approximately 6 inches (approximately 15.5 cm). In alternative embodiments, the length of the stand-offs **362** can be varied to accommodate documents of varying sizes. For example, the embodiment disclosed in FIG. **18***a* and **18***b* has an interior width, W_3 of approximately 4.12 inches (104.6 cm) and is sized to accommodate the largest international currency, the French 500 Franc note, which has width of approximately 3.82 inches (9.7 cm) and a length of approximately 7.17 inches (18.2 cm). In order to accommodate large documents and increase the interior width, W_3, of the storage cassette **118**, the lengths of stand-offs **362**, illustrated in FIG. **16***b*, are shortened.

Beginning with FIG. **7**, the operation of one of the lower output receptacles **106***c*–**106***h* will be described. Pursuant to a mode of operation, the bills **204** are directed by one of the diverters **130** into the escrow compartment **116** of the lower output receptacle. The stacker wheel **202** within escrow compartment **116** receives the bills **204** from the diverter **130**. The stacker wheel **202** stacks the bills **204** on top of the gate **210**. Pursuant to a preprogrammed mode of operation, once a predetermined number of bills **204** are stacked in the escrow compartment **116**, the control unit **120** instructs the currency handling device **100** to suspend processing currency bills and the paddle **302** then descends from its home position above the escrow compartment **116** to transfer the bills **204** into the storage cassette **118**. Once the bills **204** have been deposited in the storage cassette **118** the currency handling device resumes operation until an escrow compartment is full or all the bills within the input receptacle **102** have been processed.

Referring now to FIGS. **8** and **9** the plunger assembly **300** downwardly travels placing the paddle **302** onto of the stack of bills **204**. Upon making contact with the bills **204** the paddle **302** continues to travel downward. As the paddle **302** continues its descent, the paddle **302** forces the gate **210** to snap open. The paddle **302** imparts a force to the bills **204** that is transferred to the to the shutters **211, 212** causing the shutters **211, 212** to rotate from the closed position to the open position. The rotation of the shutters **211, 212** is indicated by the arrows B and C, respectively. Once the paddle **302** imparts the amount of force necessary to rotate levers **216, 217**, the extension springs **218, 219** quickly rotate the shutters **211, 212** downward, thus "snapping" the gate **210** open. The downward rotation of the shutters **211, 212** causes each of the corresponding parallel bars **214, 215** to pivot which in turn rotates the levers **216, 217**. The extension springs **218, 219** maintain the shutters **211, 212** in the open position allowing the paddle **302** to descend into the storage cassette **118**. The hingedly connected side arms **306, 308** retract as the rollers **316, 318** to roll around the levers **216, 217** while the plunger assembly **300** is traveling downward into the cassette **118**.

Referring now to FIG. **15**, once the gate **210** is opened, the bills **204** fall a short distance onto the platform **356** of the storage cassette **118** or onto a stack of bills **204** already deposited on the platform **356**. The paddle **302** continues its downward motion towards the storage cassette **118** to ensure that the bills **204** are transferred to the cassette **118**. Initially, some bills **204** may be spaced apart from the platform **356** or the other bills **204** within the storage cassette by retaining tabs **350**. As the plunger assembly **300** continues to descend downward into the cassette, the paddle **302** continues to urge the stack of bills **204** downward causing the retaining tabs **350** to rotate downward. The bills **204** are pushed past retaining tabs **350** and onto the platform **356**.

Once the plunger assembly **300** has descended into the cassette **118** a distance sufficient for the paddle **302** to clear the retaining tabs **350** allowing the retaining tabs **350** to rotate upward, the plunger assembly initiates its ascent out of the storage cassette **118**. The platform **356** urges the bills **204** upward against the underside of the paddle **302**. The paddle **302** is equipped with two pairs of slots **324, 326** (FIG. **9**) to enable the paddle to clear the pairs of retaining tabs **350**. When the paddle **302** ascends past the pairs of retaining tabs **350** the bills **204** are pressed against the lower surfaces **354** of the pairs of retaining tabs **350** by the platform **356**.

Referring now to FIG. **13**, when the plunger assembly **300** is traveling upward out of the cassette **118**, the rollers **316, 318** on the side arms **306, 308** engage the respective levers **216, 217** and move the respective levers **216, 217** from the second (open) position to the first (closed) position to move the gate **210** from the open position to the closed position as the paddle **302** ascends into the escrow compartment **116** after depositing the bills **204** in the storage cassette **118**. The paddle **302** is mounted on the base **304** above the rollers **316, 318** on the side arms **306, 308** so that the paddle **302** clears the gate **210** before the gate **210** is moved to the closed position.

In alternative embodiments of the currency handling device **100**, the output receptacles **106** can be sized to accommodate documents of varying sizes such as various international currencies, stock certificates, postage stamps, store coupons, etc. Specifically, to accommodate documents of different widths, the width of the escrow compartment **116**, the gate **210**, and the storage cassette **118** would need to be increased or decreased as appropriate. The document evaluation device **100** is sized to accommodate storage cassettes **118** and gates **210** of different widths. The entire transport mechanism **104** of the currency handling device **100** is dimensioned to accommodate the largest currency bills internationally. Accordingly, the document handling device **100** can be used to process the currency or documents of varying sizes.

In various alternative embodiments, the currency handling device **100** is dimensioned to process a stack of different sized currencies at the same time. For example, one application may require the processing of United States dollars (2.5 inches×6 inches, 6.5 cm×15.5 cm) and French currency (as large as 7.17 inches×3.82 inches, 18.2 cm×9.7 cm). The application may simply require the segregation of the U.S. currency from the French currency wherein the currency handling device **100** delivers U.S. currency to the first lower output receptacle **106***c* and the French currency to the second output receptacle **106***d*. In another alternative embodiment, the currency handling device **100** processes a mixed stack of U.S. ten and twenty dollar bills and French one hundred and two hundred Franc notes wherein the currency documents are denominated, counted, and authenticated. In that alternative embodiment, the U.S. ten and twenty dollar bills are delivered to the first **106***c* and second **106***d* lower output receptacles, respectively, and the French one hundred and two hundred Franc notes are delivered to the third **106***e* and fourth **106***f* lower output receptacle, respectively. In other alternative embodiments, the currency handling device **100** denominates, counts, and authenticates six different types of currency wherein, for example, Canadian currency is delivered to the first lower output receptacle **106***c*, United States currency is delivered to the second output receptacle **106***d*, Japanese currency is delivered to the third lower output receptacle **106***e*, British currency is delivered to the fourth lower output receptacle **106***f*, French currency is delivered to the fifth lower output receptacle **106***g*, and German currency is delivered to the sixth lower output receptacle **106***h*. In another embodiment, no call bills or other denominations of currency, such as Mexican currency for example, may be directed to the second upper output receptacle **106***b*. In another embodiment, suspect bills are delivered to the first upper output receptacle **106***a*.

In other alternative embodiments of the currency handling device **100**, the user can vary the type of documents delivered to the output receptacles **106**. For example, in one alternative embodiment an operator can direct, via the control unit **120**, that a stack of one, five, ten, twenty, fifty, and one-hundred United States dollar bills be denominated, counted, authenticated, and directed into lower output receptacles **106***c*–**106***h*, respectively. In still another alternative embodiment, the currency handling device **100** is also instructed to deliver other bills, such as a United States two dollar bill or currency documents from other countries that have been mixed into the stack of bills, to the second upper output receptacle **106***b*. In still another alternative embodiment, the currency handling device **100** is also instructed to count the number and aggregate value of all the currency bills processed and the number and aggravate value of each individual denomination of currency bills processed. These values can be communicated to the user via the display/user-interface **122** of the currency handling device **100**. In still another alternative embodiment, no call bills and bills that are stacked upon one another are directed to the second upper output receptacle **106***b*. In still another alternative embodiment, the operator can direct that all documents failing an authentication test be delivered to the first upper output receptacle **106***a*. In another alternative embodiment, the operator instructs the currency handling device **100** to deliver no call bills, suspect bills, stacked bills, etc. to one of the lower output receptacles **106***c*–**106***h*. The currency handling device **100** which has eight output receptacles **106***a*–**106***h* provides a great deal of flexibility to the user. And in other alternative embodiments of the currency handling device **100**, numerous different combinations for processing documents are available.

According to one embodiment, the various operations of the currency handling device **100** are controlled by processors disposed on a number of printed circuit boards ("PCBs") such as ten PCBs located throughout the device **100**. In one embodiment of the present invention, the processors are Motorola processors, model number 86HC16, manufactured by Motorola, Inc. of Schaumburg, Ill. Each of the processors are linked to a central controller via a general purpose communications controller disposed on each PCB. In one embodiment of the present invention the communications controller is an ARCNET communications controller, model COM20020, manufactured by Standard Microsystems Corporation of Hauppauge, N.Y. The communications controller enables the central controller to quickly and efficiently communicate with the various components linked to the PCBs.

According to one embodiment, two PCBs, a "motor board" and a "sensor board," are associated with each pair of lower output receptacles **106***c*–**106***h*. The first two lower output receptacles **106***c,d*, the second two lower output receptacles **106***e,f*, and the last two lower output receptacles **106***g,h* are paired together. Each of the lower output receptacles **106** contain sensors which track the movement of the bills into the lower output receptacles **106***c*–**106***h*, detect whether each storage cassette **118***a*–**118***e* is positioned within the currency handling device **100**, detect whether the doors **359** of the storage cassettes **118** are opened or closed, and whether the cassettes **118** are full. These aforementioned sensors associated with each pair of the lower output receptacles are tied into a sensor board which is linked to the central controller. The operation of the plunger assembly **300**, the stacker wheels **202**, the portion of transportation mechanism **104** disposed above the lower output receptacles **116***c*–**116***h*, and the diverters **130** are controlled by processors disposed on the motor board associated with each pair of lower output receptacle's **106***c*–**106***h*. Those sensors **130** which track the movement of bills along the transportation mechanism **104** that are disposed directly above the lower output receptacles **106***c*–**106***h* are also tied into the respective motor boards.

One of the four remaining PCBs is associated with the operation of the one or two stacker wheels **127** associated with the upper output receptacles **106***a,b*, the stripping wheels **140**, the primary drive motor of the evaluation region **108**, a diverter which direct bills to the two upper output receptacles **106***a,b*, and the diverter which then directs bills between the two upper output receptacles **106***a,b*. The remaining three PCBs are associated with the operation of the transport mechanism **104** and a diverter which directs bills from the transport path to the bill facing mechanism **110**. The plurality of sensors **130** disposed along the trans-

port mechanism **104**, used to track the movement of bills along the transport mechanism **104**, also tied into these three remaining PCBs.

Referring now to FIGS. **19–22**, a two belt bill facing mechanism **400** is illustrated. The two belt bill facing mechanism **400** is an alternative embodiment of the bill facing mechanism **110** referred to in FIGS. **1***a* and **1***b* and in the above related discussion. The two belt bill facing mechanism **400** can be used in conjunction with the currency handling device **100** shown in FIGS. **1***a* and **1***b* to rotate the face orientation of a bill **401** approximately 180°. For example, if a U.S. bill, for example, is initially presented with the surface bearing a portrait of a president facing down, it may be directed to the two belt bill facing mechanism **400**, whereupon it will be rotated 180° so that the bill surface with the portrait faces up. The decision may be taken to send a bill **401** to the facing mechanism **400** when the selected mode of operation or other operator instructions call for maintaining a given face orientation of bills as they are processed by the currency handling device **100**. For example, it may be desirable in certain circumstances for all of the bills ultimately delivered to the lower output receptacles **106***c*–**106***h* to have the same face orientation. In such embodiments of the currency handling device **100**, the bill evaluation region **108** is capable of determining the face orientation of a bill, such that a bill not having the desired face orientation can first be directed to the two belt bill facing mechanism **400** before being delivered to the appropriate lower output receptacle **106***c*–**106***h*.

The two belt bill facing mechanism **400** ("facing mechanism") includes a first belt **402** and a second belt **404**. Each of the first and the second belts **402,404** forms a continuous loop. The belts **402,404** are disposed adjacent to each other such that the opposing surfaces of each belt **402,404** forms a bill facing transport path **406**. The belts **402, 404** are twisted together so that an inlet **408** of the transport path **406** is rotated approximately 180° with respect to an outlet **410** of the transport path **406**.

The first and second belts **402, 404** are each wrapped around two rollers. The first belt **402** is positioned around a first roller **412** disposed adjacent the inlet **408** and a second roller **414** disposed adjacent the outlet **410**. The second belt **404** is positioned around a third roller **416** disposed adjacent the inlet **408** and a fourth roller **418** disposed adjacent the outlet **410**. As illustrated in FIG. **19**, the first and second rollers **412,414**, associated with the first belt, are positioned such that the first roller **412** is the "top" roller at the inlet **408** and the second roller **414** is the "bottom" roller at the outlet **410**. The third and forth rollers **416,418**, associated with the second belt, are positioned such that the third roller **416** is the "bottom" roller at the inlet **408** and the forth roller **418** is the "top" roller at the outlet **410**. This arrangement allows the for the "twisted" bill facing mechanism transport path **406**. Starting from the inlet **408**, a first end **402***a* of the first belt **402** is placed around the first roller **412** which is disposed above the third roller **416** around which a first end **404***a* of the second belt **404** is placed. Viewing FIG. **19** from right to left, the first and the second belts **402,404** are together twisted 180° out of the page. The second end **404***b* of the second belt **404** is now disposed above the second end **402***b* of the first belt **402**. The second end **404***b* of the second belt **404** is positioned around the forth roller **418** and the second end **402***b* of the first belt **402** is positioned around the third roller **414**. Between the inlet **408** and the outlet **410**, that is between the rollers, there is no structure supporting the portions of the first or the second belts **402,404** which define the bill transport path **406**. The rollers are connected to shafts **419** about which the rollers rotates. In one embodiment of the two belt bill facing mechanism, the rollers **414,418** are driven rollers and the rollers **412,416** are passive rollers. In such an embodiment, a motor (not shown) is coupled to the shafts **419** associated with driven rollers **414,418**.

Two belt guides **420** (FIGS. **19** and **20**) are used to guide the portion of the belts not defining the transport path **406** or the return portion **422** of the belts away from the transport path. The return portion **422** of the belts **402,404** is drawn away from the transport path **406** to insure that the return portion **422** does not contact a bill **401** traveling along the transport path **406** causing the bill **401** to become skewed relative to the transport path **406**. Each belt guide **420** is attached to a structure **424** which is fixed to the currency handling device **100**. In FIGS. **19** and **20**, only the first belt guide **420** is clearly illustrated. In the illustrated embodiment, each belt guide **420** includes one vertical roller and two horizontal rollers **426**. The vertical roller associated with the second belt guide **420** is labeled with reference number **427**. The interior of each belt **402,404** travels against the vertical roller. Any vertical movement of the return portion **422** of the belt is constrained by the two horizontal rollers **426** along which the edges **428,429** of the belts **402,404** travel. In an alternative embodiment, the belt guide **420** only contains one horizontal roller **426** to limit the vertical movement of the return portions of the belts.

In the embodiment illustrated in FIG. **20**, the two belt bill facing mechanism contains belt end guides **440**. The belt end guides **440** are used to maintain the position of belts **402,404** on rollers **412, 416**. The belt guides limit any horizontal movement of the belts **402, 404** at their first ends **402***a*,**404***b*. In another embodiment of the two, belt bill facing mechanism two more belt end guides are used to limit any horizontal of the belts **402,404** at the second ends **402***b*, **404***b*. The belt end guides **440** consists of a structure **442** and two rollers **444**. Because the belt guides **420** pull the return portion **422** away from the transport path **406**, the belt guide rollers **444** maintain the belt ends on the rollers **412, 414, 416, 418** and prohibit any movement of the belts **402,404** off of the rollers **412, 414, 416, 418**.

The bill facing mechanism **400** also contains four guides **431,432,433, 434** disposed along the bill transport path **406**. Each of these guides are also fixed to the structures **424**. The guides **431–434** are made out of a rigid material. A bill is transported through the bill facing mechanism (as well as the through the transport mechanism **104** of currency handling device **100**) with the leading edge of the bill being the long or wide edge of the bill **401**. The width of the bill **401** is greater than the width of the first and the second belts **402,404** causing a significant portion of the bill **401** to overhang each edge of the belts **402,404**. The function of the guides is to provide support to those portions of the bill **401** which overhang the belts **402,404**. Because of the high processing rate at which the currency handling device **100** operates, a significant angular velocity is imparted to a bill directed through the facing mechanism. In alternative embodiments of the currency handling device **100**, bills are processed at speeds in excess of 1200 bills per minute. The differences in air pressures acting on the front and the back surfaces areas of the bill **401** can cause the bill **401** to fold or be forced such that the bill is no longer being transported in a substantially flat manner. This situation can occur more readily when the bill stiffness is degraded due to bill wear resulting from heavy usage. Additionally, bills are often folded in a variety of manners which may cause a bill to be biased in a certain direction such that the bill will not lie flat

under its own weight. It is preferable for the bill **401** to be transported through the bill facing mechanism **400** (and the currency handling device **100**) in a substantially flat manner. If the bill **401** is not substantially flat when traveling from the outlet **410** of the bill facing mechanism **400** back into the bill transport mechanism **104** there is a possibility that the bill may become skewed at the interface between the outlet **410** and the transport mechanism **104** because the transport mechanism **104** may not "catch" the entire leading edge of the bill.

In operation, a bill **401**, shown in position E, enters the inlet **408** of the bill facing mechanism **400** and is transported along the bill facing transport path **406** in a direction from right to left indicated by arrow D. The bill **401** adjacent to the outlet **410** is shown in position F which is a 180° rotation from position E. Referring to the bill **401** in position E, the bill **401** has narrow edges **450,451** and surfaces **452, 453**. The first and second belts **402,404**, a portion of which define the transport path **406**, are twisted causing the bill **401** to rotate in manner such that the (near) edge **450** of the bill **401** drops into the page and the (far) edge **451** of the bill **401** rotates up and out of the page. As the bill **401** travels through the bill transport path **406**, the surface **452** towards the (near) edge **450** of the bill **401** is guided by the first guide **431**. The surface **453** towards the (far) edge **451** of the bill **401** is supported by the second guide **432**. The guides **431,432** support their respective surfaces of the bill **401** until the bill **401** is substantially in a vertical position. As the bill continues to travel towards the outlet **410** the edge **451** (now at the top of the page) continues to rotate out of the page while the edge **450** (now at the bottom of the page) rotates into the page. Continuing, the surface **453** towards the edge **451** is being guided by the guide **433**. The surface **452** towards edge **450** is being guided by the guide **434**. When the bill arrives at the outlet **410**, the orientation of the bill has been rotated 180°. The bill then merges into the transport mechanism **104** of the currency handling device **104**.

In another alternative embodiment, the currency handling device **100** operates in a strapping mode wherein pursuant to a user's input or selection of a preprogrammed mode of operation, currency bills are stacked in a manner so that smaller of stacks of bills within a larger stack of bills are readily identifiable. Typically, in the handling of bulk currency, after the currency bills have been analyzed, denominated, authenticated, counted, and/or otherwise processed, the currency bills are strapped. Bill strapping is a process whereby a stack of a specific number of bills of a single denomination are secured together such as with a paper strap. For example, one dollar bills are segregated into stacks of one-hundred one dollar bills and then bound with a paper strap. Strapping facilitates the handling of bulk currency allowing the strapped stacks of bills to be counted rather than the individual currency bills.

When operating pursuant to a strapping mode, the currency handling device **100** stacks currency bills in the lower output receptacles **106***c*–**106***h* in a manner so that smaller batches of currency bills are readily identifiable such as by alternating the face orientation of the smaller batches of bills within the stack. Put another way, as illustrated in FIG. **23**, every other smaller stack **550** of bills comprising the larger stack **552** of bills is either orientated with the surface of the bill bearing the portrait of the president face-up or face-down. This arrangement allows a user of the currency handling device **100** to quickly segregate the smaller stacks **550** from the larger stack **552** of bills for strapping purposes after the user removes the larger stack **552** of bills from the storage cassette **118***a*–*f* associated with a corresponding lower output receptacle **106***c*–*h*. For example, a user desiring to "strap" U.S. $20 bills would instruct the currency handling device accordingly, so that the face-orientation of every batch of one-hundred $20 bills would alternate.

A bill turnover mechanism, such as for example, either the two belt bill facing mechanism **400**, illustrated in FIGS. **19–22**, or the bill facing mechanism **110**, referred to in FIGS. **1***a* and **1***b*, can be incorporated into the currency handing device **100** to vary the face orientation of the bills pursuant to a strapping mode so that the individual currency bills within each smaller stack **550** of currency bills has a common face orientation. Alternatively, in other embodiments of the present invention, other turnover mechanisms can be used.

The total number of bills per smaller stack **550** of currency bills is referred to as a "limit." The "limit" is a predetermined number which is either defined by the user of the currency handling system **100** or is defined by a mode of operation. In one embodiment, the user defines via the user interface **122** that the limit is, for example, fifty currency bills. Accordingly, the face orientation of every fifty currency bills is alternated. In another alternative embodiment, a user selects via the user interface **122** a "$20 strapping mode" wherein, for example, the limit is predefined at one hundred $20 bills. While any number of bills can be included in a strap of currency bills, U.S. currency bills are traditionally strapped in one-hundred bill stacks.

Referring also to FIG. **24**, the steps performed in a strapping mode of operation will be described in detail. For purposes of this example, the stack of bills consists of U.S. $20 bills arranged in both face orientations. Initially at steps **502, 504**, and **506**, the limit is defined, the bill count is set to zero, and the target orientation is defined, respectively. The target face orientation is the face orientation in which the first smaller stack of bills are to have when stacked in a particular output receptacle **106***c*–**106***h* such as output receptacle **106***f*. The target orientation, either face-up or face-down, can be predetermined pursuant to a mode of operation or be input by a user at step **506**. In an alternative embodiment of the currency handling device **100**, the target orientation can be defined as the orientation of the first currency bill transported though the evaluation region **108** or the first currency bill of a given denomination transported though the evaluation region **108**. The initial target orientation dictates the orientation of the first smaller currency bill stack **550** stacked on the platform **356** of a particular storage cassette **118***a*–*f*. Accordingly, the initial target orientation of the strapping mode which resulted in the stack of currency bills illustrated in FIG. **23** was face-up.

Upon the commencement of the operation of the currency handling device **100**, the bills are transported one at a time through the evaluation region **108** to one of the output receptacles **106***c*–*h*. At step **508**, while being transported through the evaluation region **108**, the face orientation of each of the bills is determined. The face orientation of the bill currently being evaluated is compared to the target orientation at **510**. If the orientation of the currency bill currently being evaluated matches the target orientation, the face orientation of the bill is maintained at step **512** and the bill is transported to a particular one of the output receptacles **106***c*–*h* at step **514**. If the orientation of the currency bill currently being evaluated fails to match the target orientation, the bill is first transported to the bill facing mechanism **400** at step **516**, where the face orientation of the bill is reversed as the bill is rotated 180°. The properly faced bill is then transported to and stacked in a particular one of the output receptacles **106***c*–*h* at step **514**. As each bill is

transported to the output receptacle **106***c–h*, at step **516**, a bill counter increases by one until the number of bills transported to the particular output receptacle **106***c–h* having a common face orientation is equivalent to the strap limit. The strap limit is compared to the bill count at step **518**. When the bill count is equivalent to the strap limit, the target face orientation is redefined to be the other of the two face orientations—face-up or face-down —at step **520**. The bill count is then reset to zero at step **522**. The currency evaluation device continues to operate in this manner until the entire batch of currency bills is processed.

The foregoing is one example of the steps performed in processing currency bills with the currency handling device **100** pursuant to a stacking mode of operation. In alternative embodiments, the sequence in which the steps are performed can be rearranged in a variety of other orders or combined. For example, in an alternative embodiment, the steps Define The Limit **502**, Set Bill Count To Zero **504**, and Define The Target Orientation **506** can be combined in a preprogrammed strapping mode of operation which the user simply selects from the user interface **122**. For example, a "$50 strapping" mode of operation may be selected by the user, via the user interface **122**, wherein the limit is predefined at one-hundred bills, the bill count is set to zero, and the initial target orientation is defined as face-down.

In alternative embodiments of the present invention, the currency bills can be processed into the lower output receptacles **106***c–h* in a variety of manners. For example, in one embodiment, bills are processed into the escrow region **116** until the escrow region **116** is full. At that time, the plunger assembly **300** transfers the bills from the escrow region **116** to the corresponding storage cassette **118**. The currency handling device **100** operates in this manner until all of the bills have been processed into the storage cassette(s) **118**. If, after all of the bills have been processed, a smaller stack of bills has been delivered to a storage cassette **118** containing a number of bills which is less than the strap limit, the currency handling device **100** can notify the user via the user interface **122**. In still another alternative embodiment, after a number of bills equivalent to the strap limit are processed into the escrow region **116**, the plunger assembly **300** transfers the bills to the storage cassette **300**. In this embodiment of a strapping mode of operation, all of the smaller stacks of bills in the storage cassette comprise a number of bills equivalent to the strap limit. A stack of bill comprising a number of currency bill less then the limit remains in the escrow region until either the stack is removed by the operator of the currency handling device **100** or until the stack is supplemented with bills from an additional batch of currency processed by the currency handling device.

After the entire batch of currency bills is processed into the lower output receptacles **106***c–h* pursuant to a strapping mode of operation, a user of the currency handing device **100** removes the stacks of bills from each storage cassette **118***a–f* associated with corresponding lower output receptacles **106***c–h*. Because the smaller stacks of bills within each of the larger stacks of bills removed from the storage cassettes **118***a–f* are arranged with alternating face orientations, the user can quickly segregate the smaller stacks from the larger stacks and bind each of the smaller stacks with a strap.

In an alternative embodiment of the present invention, larger stacks of bills comprising smaller stacks of bills having alternative face orientations, such as illustrated in FIG. **23**, can be formed in the lower output receptacles **106***c–h* without using the bill facing mechanism. In such an embodiment, face-up bills are transported to a "target" lower output receptacle and face-down bills are transported to another target lower output receptacle until the limit is reached in both lower output receptacles. The target receptacles **106** are then switched and the process is repeated. For example, bills of a given denomination having a face-up orientation are routed to the first lower output receptacle **106***c* and bills of the same denomination having a face-down orientation are routed to the second lower output receptacle **106***d*. Face-up and face-down bills continue to be processed into the first and second lower output receptacles **106***c,d*, respectively, until a number of bills equivalent to the limit have been processed into the first and second lower output receptacles **106***c,d*. At that time, the face-up bills are then routed to the second lower output receptacle **106***d* and the face-down bills are routed to the first lower output receptacle **106***c*. Bills continue to be processed in this manner until the limit is again reached in both the first and second lower output receptacles **106***c,d* at which time the target lower output receptacles **106** of the face-up and face-down bills are again switched. The process continues as described until the entire batch of currency is processed and each of the lower output receptacles **106***c,d* contain larger stacks of bills comprising smaller stacks having alternating face orientations. Obviously, the limit will be reached in one of the two lower output receptacles **106***c,d* before the other of the two lower output receptacles **106***c,d*. Accordingly, the excess bills are off-sorted or, alternatively, a similar method is perform in the adjacent lower output receptacles **106***e,f*. For example, when the limit is first reached with respect to face-up bills directed to the first lower output receptacle **106***c*, those face-up bills are then routed to the third lower output receptacle **106***e* while face-down bills continue to be directed to the second lower output receptacles **106***d*. Should the limit be reached in the third lower output receptacle **106***e* before the second lower output receptacle **106***d*, the face-up bills can then be directed to the next lower output receptacle **106***f*. When the limit in the second output receptacle **106***d* is eventually reached, the target lower output receptacles **106***c,d* of the face-up and face-down bills can be switched as described. While the above example was discussed in conjunction with the processing of only one denomination of currency bills, in other alternative embodiments more than one denomination of currency bills can be processed in a similar manner.

In still other alternative embodiments of the present invention, smaller stacks of bills can be distinguished, for strapping purposes, from larger stacks of bills processed into lower output receptacles in a variety of other manners without alternating the face orientation of consecutive smaller stacks of bills. In one alternative embodiment, dividers such as sheets of paper are injected into the flow of currency bills so that the sheets of paper are disposed between each of the smaller stacks of currency bills. These "separation sheets" may be any one of a variety of colors that are readily distinguishable from the currency bills being processed such as, for example, fluorescent orange, pink, yellow, red, etc. Sheets which are readily distinguishable from the currency bills being processed will facilitate the user's identification and segregation of the smaller stacks of currency bills within the larger stack. In other embodiments, a marking on the "separation sheets" denoting the quantity of bills, the denomination of the bills, and/or the value of each smaller stack of bills may provide information to the user of the currency handling device **100**.

In still another alternative embodiment, rather than reversing the face orientation of the bills to distinguish the smaller stacks of currency bills, each of the smaller stacks

554 are slightly offset from the previous smaller stack as illustrated in FIG. 25*a*. In such an embodiment, each consecutive smaller stack **554** of bills comprising the larger **556** stack may be offset so that the larger stack **556** of bills appear "stepped" in shape. Alternatively, as illustrated in FIG. 25*b*, each smaller stack of bills **558** are off-set to the left and to the right of a center C of the platform **356** of the storage cassette **118** in which the bills are stacked so that the side of the larger stack of bills **560** appear corrugated in shape.

Many of the aforementioned modes of operation can be combined with a strapping mode in a multitude of alternative embodiments of the present invention. For example, in an alternative embodiment of the present invention, several denominations of U.S. currency bills may be processed pursuant to a strapping mode of operation. In such an embodiment U.S. $1, $5, $10, $20, $50, and $100 bills are processed pursuant to a strapping mode of operation into the lower output receptacles **106***c–h*, respectively—while alternating the face orientation of every set of one-hundred bills within each of the output receptacles. Accordingly, in such an embodiment, the currency handling device must denominate each of the currency bills being processed. Continuing with the current example, when a non-U.S. $1, $5, $10, $20, $50, or $100 bill is detected, such as a Canadian $1 bill or a U.S. $2 bill, that bill is off sorted to one of the upper output receptacles **106***a,b*. Further, the currency handling device **100** can also authenticate each of the currency bills being processing pursuant to a strapping mode of operation. Non-authentic bills can be routed to upper output receptacles **106***a,b* as well. Alternatively, non-authentic bills can be routed to upper output receptacle **106***a* and non-U.S. $1, $5, $10, $20, $50, or $100 bills or no call bills are routed to upper output receptacles **106***b*.

In other alternative embodiments, the currency handling device **100** is capable of denominating, authenticating, and facing for strapping purposes batches of bills containing several different international currencies. For example, in one embodiment of the present invention, a user may desire to segregate, denominate, authenticate, and stack for strapping purposes U.S. $20, $50, $100 bills and Canadian $20, $50, $100 bills. The U.S. $20, $50, $100 dollar bills may be directed to the first three lower output receptacles **106***c–e* and the Canadian $20, $50, $100 bills may be directed to the second three lower output receptacles **106***f–h*. Accordingly, the currency handling device must denominate each of the currency bills before directing the bills to a lower output receptacle **106***c–h*. Non-U.S. $20, $50, $100 bills and non-Canadian $20, $50, $100 are directed to one of the upper output receptacles **106***a,b* such as the second upper output receptacle **106***b*. The bills may also be authenticated. Authentic U.S. $20, $50, $100 bills and Canadian $20, $50, $100 are directed to the appropriate lower output receptacles **106***c–h*. Those bills which are not authenticated, suspect bills, can be routed to the first upper output receptacle **106***a*. Further, non-U.S. $20, $50, $100 suspect bills and non-Canadian $20, $50, $100 suspect bills can also be directed to the first upper output receptacle **106***a*. Additionally, in other alternative embodiments of the present invention, modular output receptacles can be added so that, for example, U.S. $5 and $10 bills are processed in the same manner along side the U.S. $20, $50, $100 bills and Canadian $20, $50, $100 bills.

As is apparent from the foregoing discussion, a strapping mode of operation can be combined with other modes of operation to instruct the currency handling device to operate in a multitude of different variations.

While the invention is susceptible to various modifications and alternative forms, specific embodiments thereof have been shown by way of example in the drawings and herein described in detail. It should be understood, however, that it is not intended to limit the invention to the particular forms disclosed, but on the contrary, the intention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the invention as defined by the appended claims.

What is claimed is:

1. A method of creating identifiable smaller stacks of currency bills within a larger stack of currency bills using a currency evaluation device, the method comprising:

(a) receiving a stack of currency bills in an input receptacle;

(b) transporting the bills from the input receptacle, one at a time, past an evaluating unit to at least one output receptacle;

(c) identifying the face orientation of each of the bills with the evaluating unit; and either

(1) maintaining the orientation of a bill when the orientation of the bill matches a target orientation; or

(2) reversing the orientation of a bill when the orientation of the bill does not match the target orientation;

(d) stacking a predetermined number of bills in the at least one output receptacle, the predetermined number of bills having a common face orientation;

(e) redefining the target orientation to be the other of the two face orientations after the predetermined number of bills have been transported to the at least one output receptacle; and

(f) repeating (b), (c), (d), and (e), until each of the bills are transported from the input receptacle.

2. The method of claim **1** further comprising determining the authenticity of each of the currency bills.

3. The method of claim **1** further comprising determining the denomination of each of the currency bills.

4. The method of claim **3** further comprising totaling the value of the currency bills transported to the at least one output receptacle.

5. The method of claim **1** wherein the at least one output receptacle comprises a plurality of output receptacles.

6. The method of claim **5** further comprising:

determining the authenticity of each of the currency bills; and

routing a bill to a particular one of the plurality of output receptacles when the authenticity of the bill cannot be determined.

7. The method of claim **5** further comprising:

determining the denomination of each of the currency bills; and

routing a bill to a particular one of the plurality of output receptacles when the denomination of the bill cannot be determined.

8. The method of claim **1** further comprising defining an initial target orientation to be the face orientation of a first bill transported from the input receptacle.

9. The method of claim **1** wherein reversing the face orientation of a bill further comprises reversing the face orientation of a bill with a bill facing mechanism.

10. A method of creating identifiable smaller stacks of currency bills within a larger stack of currency bills using a currency evaluation device, the method comprising:

(a) defining a target orientation to be one of two face orientations, one of the two face orientations being face-down, the other of the two face orientations being face-up;

(b) receiving a stack of currency bills in an input receptacle;

(c) transporting each of the bills from the input receptacle, one at a time, past an evaluating unit to at least one output receptacle;

(d) identifying the face orientation of each of the bills with the evaluating unit; and either

(1) maintaining the orientation of the bill when the orientation of the bill matches the target orientation; or

(2) reversing the orientation of the bill when the orientation of the bill does not match the target orientation;

(e) stacking a predetermined number of bills in the at least one output receptacle, the predetermined number of bills having a common face orientation;

(f) redefining the target orientation to be the other of the two face orientations after a predetermined number of bills having been transported to the at least one output receptacle; and

(g) repeating (c), (d), (e), and (f) until each of the bills are transported from the input receptacle.

11. The method of claim **10** further comprising determining the authenticity of each of the currency bills.

12. The method of claim **10** further comprising determining the denomination of each of the currency bills.

13. The method of claim **12** further comprising totaling the value of the currency bills transported to the output receptacle.

14. The method of claim **10** wherein the at least one output receptacle comprises a plurality of output receptacles.

15. The method of claim **14** further comprising:

determining the authenticity of each of the currency bills; and

routing a bill to a particular one of the plurality of output receptacles when the authenticity of the bill cannot be determined.

16. The method of claim **14** further comprising:

determining the denomination of each of the currency bills; and

routing a bill to a particular one of the plurality of output receptacles when the denomination of the bill cannot be determined.

17. The method of claim **10** wherein defining a target orientation further comprises defining the target orientation to be the face orientation of a first bill transported from the input receptacle.

18. The method of claim **10** wherein reversing the orientation of a bill further comprises reversing the face orientation of a bill with a bill facing mechanism.

19. A method of creating identifiable smaller stacks of currency bills within a larger stack of currency bills with a currency evaluation device, the method comprising:

receiving a stack of currency bills in an input receptacle;

transporting each of the bills from the input receptacle, one at a time, past an evaluating unit to at least one output receptacle;

identifying the face orientation of each of the bills with the evaluating unit, the face orientation of the bills being one of two face orientations, one of the two face orientations being face-down, the other of the two face orientations being face-up;

defining a target orientation to be the face orientation of a first bill transported from the input receptacle;

comparing the face orientation of each of the bills with the target orientation;

maintaining the face orientation of a bill when the face orientation of the bill matches the target orientation;

reversing the face orientation of a bill when the face orientation of the bill does not match the target orientation;

stacking a predetermined number of bills in the at least one output receptacle, the predetermined number of bills having a common face orientation;

redefining the target orientation to be the other of the two face orientations after the predetermined number of bills having a common face orientation have been stacked in the at least one output receptacle; and

repeating the above method, beginning with transporting the bills until each of the bills are transported from the input receptacle.

20. The method of claim **19** further comprising determining the authenticity of each of the currency bills.

21. The method of claim **19** further comprising determining the denomination of each of the currency bills.

22. The method of claim **21** further comprising totaling the value of the currency bills transported to the output receptacle.

23. The method of claim **19** wherein the at least one output receptacle comprises a plurality of output receptacles.

24. The method of claim **23** further comprising:

determining the authenticity of each of the currency bills; and

routing a bill to a particular one of the plurality of output receptacles when the authenticity of the bill cannot be determined.

25. The method of claim **23** further comprising:

determining the denomination of each of the currency bills; and

routing a bill to a particular one of the plurality of output receptacles when the denomination of the bill cannot be determined.

26. The method of claim **19** wherein reversing the face orientation of a bill further comprises reversing the face orientation of a bill with a bill facing mechanism.

27. A method of creating identifiable smaller stacks of currency bills within a larger stack of currency bills with a currency evaluation device, the method comprising:

receiving a stack of currency bills of a plurality of denominations in an input receptacle;

transporting the bills from the input receptacle, one at a time, past an evaluating unit to a plurality of output receptacles, the plurality of output receptacles corresponding to the plurality of denominations;

assigning a target orientation to each of the plurality of output receptacles,

defining the target orientation assigned to each of the plurality of output receptacles to be one of two face orientations, one of the two face orientations being face-down, the other of the two face orientations being face-up;

determining the denomination and face orientation of each of the bills with the evaluating unit;

comparing the face orientation of a bill with the target orientation assigned to the output receptacle corresponding to the determined denomination of the bill;

maintaining the orientation of the bill when the orientation of the bill matches the target orientation;

reversing the orientation of the bill when the orientation of the bill does not match the target orientation;

routing the bill to the output receptacle corresponding to the determined denomination of the bill;

redefining the target orientation assigned to an output receptacle to be the other of the two face orientations after a predetermined number of bills of having a denomination corresponding to the output receptacle have been routed to the output receptacle with a common face orientation; and

repeating the above method, beginning with transporting the bills until each of the bills are transported from the input receptacle.

28. The method of claim **27** further comprising determining the authenticity of each of the currency bills.

29. The method of claim **28** further comprising off-sorting a bill to a particular one of the plurality of output receptacles when the authenticity of the bill can not be determined.

30. The method of claim **27** further comprising totaling the value of the bills transported to the output receptacle.

31. The method of claim **27** further comprising off-sorting a bill to a particular one of the plurality of output receptacles when the denomination of the bill can not be determined.

32. The method of claim **27** wherein reversing the face orientation of a bill further comprises reversing the face orientation of a bill with a bill facing mechanism.

33. A method of creating identifiable smaller stacks of currency bills within larger stacks of currency bills using a currency evaluation device, the method comprising:

(a) defining a target face orientation to be one of two face orientations for each of a plurality of currency bill denominations, one of the two face orientations being face-down, the other of the two face orientations being face-up;

(b) receiving a stack of currency bills of a plurality of denominations in an input receptacle;

(c) transporting the bills from the input receptacle, one at a time, past an evaluating unit to a plurality of output receptacles, the plurality of output receptacles corresponding to the plurality of denominations;

(d) determining the denomination of each of the currency bills with the evaluating unit;

(e) identifying the face orientation of each of the bills with the evaluating unit; and either

(1) maintaining the orientation of a bill when the orientation of the bill matches the target orientation associated with the determined denomination of the bill; or

(2) reversing the orientation of a bill when the orientation of the bill does not match the target orientation associated with the determined denomination of the bill;

(f) routing each of the bills to one of the plurality of output receptacles corresponding to the determined denomination of the bill;

(g) stacking a predetermined number of bills in the plurality of output receptacles corresponding to the determined denominations of the bills;

(h) redefining the target orientation associated with a particular denomination after a predetermined number of bills have been routed to the particular output receptacle corresponding to the particular denomination; and

(i) repeating (c), (d), (e), (f), (g), and (h) until each of the bills are transported from the input receptacle.

34. The method of claim **33** further comprising determining the authenticity of each of the currency bills.

35. The method of claim **34** further comprising routing a bill to a particular one of the plurality of output receptacles when the authenticity of the currency bill can not be determined.

36. The method of claim **33** further comprising totaling the value of the currency bills transported to the output receptacle.

37. The method of claim **33** further comprising routing a bill to a particular one of the plurality of output receptacles when the denomination of the currency bill can not be determined.

38. The method of claim **33** wherein defining a target face orientation further comprises defining the target face orientation to be the face orientation of a first bill transported from the input receptacle.

39. A currency evaluation device for receiving a plurality of bills and evaluating and arranging the bills in a stack, wherein the stack includes a plurality of identifiable smaller stacks, the device comprising:

an input receptacle adapted to receive a plurality of bills to be processed;

at least one output receptacle adapted to receive the bills after the bills have been processed;

a transport mechanism adapted to transport the bills, one at a time, from the input receptacle to the at least one output receptacle;

an evaluating unit adapted to determine the face orientation of each of the bills and to produce a signal indicative of the face orientation of each of the bills;

a bill facing mechanism adapted to rotate a bill approximately 180° to reverse the face orientation of a bill; and

a controller adapted to receive the signal from the evaluating unit and to cause the transport mechanism to direct a bill to the bill facing mechanism when the face orientation of the bill does not match a target orientation so that a predetermined number of bills are transported to the output receptacle with a common face orientation, the controller being adapted to redefine the target orientation after a predetermined number of bills are transported to the output receptacle with a common face orientation.

40. The currency evaluation device of claim **39** wherein an initial target orientation is the face orientation of a first bill transported from the input receptacle.

41. The currency evaluation device of claim **39** further comprising a user interface being adapted to receive operational instructions from an operator and to display information concerning the bills.

42. The currency evaluation device of claim **41** wherein the operational instructions define an initial target orientation.

43. The currency evaluation device of claim **41** wherein the operational instructions define the predetermined number.

44. The currency evaluation device of claim **39** wherein the evaluating unit is adapted to determine the denomination of the bills.

45. The currency evaluation device of claim **44** wherein the evaluating unit is adapted to determine the value of the currency bills transported to the at least one output receptacle.

46. The currency evaluation device of claim **39** wherein the evaluating unit is adapted to determine the authenticity of the bills.

47. The currency evaluation device of claim **39** wherein the at least one output receptacle comprises a plurality of output receptacles.

48. The currency evaluation device of claim 47 wherein the evaluating unit is adapted to determine the denomination of each of the bills and to produce a signal indicative of the determined denomination of the bill, the controller being adapted to receive the signal indicative of the determined denomination and to route the bill to a particular one of the plurality of output receptacles based on the determined denomination.

49. The currency evaluation device of claim 48 wherein the evaluating unit is adapted to produce a no call error signal when the denomination of a bill cannot be determined, the controller being adapted to receive the no call error signal and to route the bill triggering the no call error signal to a particular one of the plurality of output receptacles.

50. The currency evaluation device of claim 47 wherein the evaluating unit is adapted to determine the authenticity of each of the bills and to produce suspect document error signal when the authenticity of the bill cannot be determined, the controller being adapted to receive the suspect document error signal and to route the bill triggering the suspect document error signal to a particular on of the plurality of output receptacles.

51. A currency evaluation device for receiving a plurality of bills of mixed denominations and evaluating and arranging the bills in larger stacks, wherein the larger stacks include a plurality of identifiable smaller stacks of currency bills, the device comprising:

an input receptacle adapted to receive a stack of bills of a plurality of denominations;

a plurality of output receptacles adapted to receive the bills after the bills have been evaluated, the plurality of output receptacles corresponding to the plurality of denominations;

a transport mechanism adapted to transport the bills, one at a time, from the input receptacle to the plurality of output receptacles;

an evaluating unit adapted to determine the denomination and the face orientation of each of the bills;

a bill facing mechanism adapted to rotate a bill approximately 180° to reverse the face orientation of a bill; and

a controller adapted to cause the transport mechanism to direct a bill to the bill facing mechanism when the face orientation of the bill does not match a target orientation associated with the determined denomination of the bill, the controller being adapted to cause the transport mechanism to direct a bill to the output receptacle associated with the determined denomination of the bill, the controller being adapted to redefine the target orientation associated with a particular denomination after a predetermined number of bills are transported to the output receptacle associated with the particular denomination with a common face orientation.

52. The currency evaluation device of claim 51 wherein an initial target orientation is the face orientation of a first bill transported from the input receptacle.

53. The currency evaluation device of claim 51 further comprising a user interface being adapted to receive operational instructions from an operator and to display information concerning the bills.

54. The currency evaluation device of claim 53 wherein the operational instructions define an initial target orientation.

55. The currency evaluation device of claim 53 wherein the operational instructions define the predetermined number.

56. The currency evaluation device of claim 51 wherein the evaluating unit is adapted to determine the value of the currency bills transported to the plurality of output receptacles.

57. The currency evaluation device of claim 51 where the controller is adapted to caused the transport mechanism to direct a bill to a particular one of the plurality of output receptacles when the evaluating unit cannot determine the denomination of the bill.

58. The currency evaluation device of claim 51 wherein the evaluating unit is adapted to determine the authenticity of the bills.

59. The currency evaluation device of claim 51 where the controller is adapted to caused the transport mechanism to direct a bill to a particular one of the plurality of output receptacles when the evaluating unit cannot determine the authenticity of the bill.

60. A method of creating identifiable groups of currency bills within a stack of currency bills with a currency evaluation device having a bill facing mechanism, the method comprising:

receiving a stack of currency bills in an input receptacle;

transporting each of the bills from the input receptacle, one at a time, past an evaluating unit to at least one output receptacle;

identifying the face orientation of each of the bills with the evaluating unit;

stacking the bills in the at least one output receptacle such that the face orientation of each group of bills stacked in the at least one output receptacles alternates from the previous group of bills stacked in the at least one output receptacle each group comprising a predetermined number of bills.

61. The method of claim 60 further comprising determining the authenticity of each of the currency bills.

62. The method of claim 60 further comprising determining the denomination of each of the currency bills.

63. The method of claim 62 further comprising totaling the value of the currency bills transported to the output receptacle.

64. The method of claim 60 wherein the at least one output receptacle comprises a plurality of output receptacles.

65. The method of claim 64 further comprising:

determining the authenticity of each of the currency bills; and

routing a bill to a particular one of the plurality of output receptacles when the authenticity of the bill cannot be determined.

66. The method of claim 64 further comprising:

determining the denomination of each of the currency bills; and

routing a bill to a particular one of the plurality of output receptacles when the denomination of the bill cannot be determined.

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